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WHITE OAK LABORATORY

PREDICTION OF IMPACT PRESSURES, FORCES, AND MOMENTS DURING VERTICAL AND OBLIQUE WATER ENTRY

15 JANUARY 1977

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An engineering tool is described for calculating pressures and loads at high-speed water entry which is simple to use, inexpensive to exercise and applicable to a wide variety of geometries. A simplified potential model is used which replaces the water's free surface with an effective planar surface that is positioned using an empirical parameter available in the literature for a wide variety of shapes. To confirm predictions, calculations are compared to experiment for the oblique water entry of spheres, →

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cones, disks, and cusps. Surface pressures agree well with measurement reflecting both the model geometry and location on the model. The calculated drag and lift exhibit close agreement with experimental values, particularly prior to the peak loads. At later times the shape of the hydraulic cavity must be taken into account and an approximate procedure for doing this is described. A computer code listing and sample computer runs are provided as well as instructions for using the code.

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PREDICTION OF IMPACT PRESSURES, FORCES, AND MOMENTS DURING VERTICAL AND OBLIQUE WATER ENTRY

This report describes a method for predicting pressures, forces, and moments on arbitrary bodies during vertical and oblique water entry. Also included is a listing of the computerized form of the technique, sample computer runs, and user instructions.

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C. A. Fisher

C. A. FISHER
By direction

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LIST OF SYMBOLS

C_p	pressure coefficient $(p - p_\infty)/(1/2\ \rho\ V_I^2)$
C_{D_∞}	drag coefficient assuming a constant model velocity
C_D	(drag force)/$(1/2\ \rho\ V_I^2)/(\pi D^2/4)$
C_X	(force along x axis)/$(1/2\ \rho\ V_I^2\ \pi\ D^2/4)$
C_N	(force along y axis)/$(1/2\ \rho\ V_I^2)/(\pi\ D^2/4)$
C_{MX}, C_{MY}, C_{MZ}	(moment about the x,y, and z axis respectively)/ $(1/2\ \rho\ V_I^2)/(\pi D^3/4)$
C_w	wetting factor, h/h'
D	model diameter
$\overline{e}_n$	unit vector normal to the body surface
$\overline{e}_v$	unit vector parallel to the entry velocity vector
$\overline{k}$	unit vector in the z direction
h	model depth below effective planar surface (see Fig. 1)
h'	model depth below original surface (see Fig. 1)
Δh	increment in effective depth between successive steps
N	number of elements in the model
p	pressure
r	$\sqrt{x' + y'}$
t	time
t^*_m	$V_I t/D$ where t is measured from initial model impact
t^*_c	$V_I t/D$ where t is the length of time the element centroid has been submerged
t^*_e	$V_I t/D$ where t is measured from initial impact of the element
V	fluid velocity = $-\nabla\phi$

LIST OF SYMBOLS (Continued)

V_I	initial entry velocity of center of gravity
V_E	velocity of points on the model surface
V_s	surface velocity
V_p	velocity of the deepest point on the model
V_ξ, V_η, V_γ	velocity component in the element coordinate system (ξ,η,γ)
x, y, z	water surface coordinate system which is located on the surface at the point of initial model contact with the water (see Fig. 1)
x', y', z'	model fixed coordinate system (see Fig. 1)
x", y", z"	see Fig. 6
x_{cp}	(center of pressure measured from the model nose)/d
z_c	depth of element centroid
α	see Fig. 25
β	$\tan^{-1}\{-y'/r\}$
θ	entry angle (measured from the horizontal)
θ_c	cone half angle
θ_ℓ	$\tan^{-1}$ (dr/dz') where z' is axial distance along the entry body and r is the local body radius
ξ,η,γ	element coordinate system. The γ axis is perpendicular to the element surface while η and ξ are in the plane of the element
ρ	density
ϕ	velocity potential

Superscript

^	nondimensionalized - see Eqs. (6)

INTRODUCTION

A common problem in the design of bodies which enter the water at high speeds is the determination of the surface pressures, forces and moments during water impact. This paper describes an engineering method for calculating these quantities. A simplified potential model is used which replaces the water's free surface with an effective planar surface that is positioned using an empirical parameter available in the literature for a wide variety of shapes. To confirm predictions, calculations are compared to experiment for the oblique entry of spheres, disks, and ogives and for the vertical entry of spheres, cones, ogives, and cusps. Surface pressures agree well with measurement reflecting both the model geometry and location on the model. The calculated drag and lift exhibit close agreement with experimental values, particularly prior to the peak loads. At later times the shape of the hydraulic cavity must be taken into account and an approximate procedure for doing this is described. A program listing and sample runs are provided as well as instructions for using the code.

Attempts to analyze the water-entry problem originate circa 1929 with the work of von Karman[1]. Comprehensive surveys of this field are provided by May[2], Thigpen[3], Szebehely[4], and Moran[5]. The main thrust of early work follows the formulation developed by von Karman and Wagner[6]. In this approach a potential

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[1] von Karman, T., "The Impact on Seaplane Floats During Landing," NACA TN 321, Oct 1929

[2] May, Albert, "Forces at Water Impact," Alden Research Laboratories, ARL 119-72/SP, Dec 1972

[3] Thigpen, A., "Water-Entry Technology - A Review," Sandia Corporation Technical Report SC-Dr 71 0196 (Jun 1971)

[4] Szebehely, V. G., "Hydrodynamic Impact," Appl. Mech. Rev., 12, 297-300, 1959

[5] Moran, J. P., "On the Hydrodynamic Theory of Water Exit and Entry," Therm Advanced Research Technical Report TAR-TR 6501 (Mar 1965)

[6] Wagner, H., "Über Stoss-und Gleitvorgänge an der Oberfläche von Flüssigkeiten," ZAMM 12, 4, 193-215, 1932

flow model is used and forces are calculated by the added mass concept. The submerged portion of the body is often fitted or replaced by another with the same surface cross-sectional area for which a closed form solution is available. A linearized version of the free-surface boundary conditions is applied to determine the surface shape. Most of the theories are restricted to vertical entry of simple geometries. In recent years, computational efforts have been made to obtain a solution using the non-linear boundary conditions. An early example of such work is that of Chu and Falconer[7]. A relaxation method was used to solve the potential problem for arbitrary bodies. This project was abandoned due to problems with excessive computational time and surface contact discontinuities. The same formulation for the vertical entry of cones has been treated by Weber[8] using a distribution of source dipoles. More recently, Shere and Vander Vorst[9] and Vander Vorst and Rogers[10] have used the marker and cell method to develop a detailed viscous model of vertical cone entry.

The objective of the current study has been to develop an engineering tool for calculating pressures and loads which is simple to use, inexpensive to exercise, and applicable to a wide variety of geometries. Accordingly, the philosophy of the current program has been to include only those portions of the problem which can be shown empirically to be necessary. The current work combines a simple flow field model with the potential flow computational techniques of Hess and Smith[11] to form an extremely versatile approach which can be applied to a wide variety of geometries over a broad range of entry conditions. The success of this calculative method indicates that a detailed description of the free surface is not necessary for the purposes of calculating entry pressures and loads.

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[7] Chu, W. -H., and Falconer, D. R., "Further Development of a More Accurate Method for Calculating Body-Water Impact Pressures," Southwest Res. Inst. Tech. Report No. 5, 1963

[8] Weber, C. F., "The Vertical Water Entry of a Cone," NOLTR 69-26, Jan 1969

[9] Shere, K. D. and Vander Vorst, M. M., "Vertical Water Entry of Finite Cones - A Numerical Calculation," Naval Surface Weapons Center, White Oak Laboratory, NOLTR 73-22, 1973

[10] Vander Vorst, M. J., and Rogers, J. C. W., "Calculation of Vertical Water Entry by the Partial Cell Marker and Cell Method," Proceedings of the 1976 Heat Transfer and Fluid Mechanics Institute, McKillop, Vaugh, and Dwyer, Standford U. Press 1976

[11] Hess, J. L. and Smith, H. M. O., "Calculation of Potential Flow About Arbitrary Bodies," Progress in Aeronautical Sciences, Edited by D. Kuchemann, Vol. 8, pp 1-138, 1967, Pergamon Press, New York, New York

PROBLEM FORMULATION

The flow field about the entering body is assumed to be described by a potential model. The free surface is simulated with an effective planar surface whose location is defined using the measured wetting factor C_w. This parameter is equal to the ratio of h/h' where h is the effective depth of the model and h' is its actual depth or penetration below the original free surface (see Fig. 1). The governing equations and boundary conditions are:

Governing equation:

$$\nabla^2 \phi = 0 \tag{1}$$

Boundary conditions:

(a) On body surface:

$$-\nabla\phi \cdot \bar{e}_n = \bar{V}_E \cdot \bar{e}_n \tag{2}$$

(b) On the effective planar surface:

$$\left\{ \begin{array}{l} V_s = -(C_w - 1)\bar{V}_p \cdot \bar{k} \quad \text{(3a)} \\ \phi = 0 \quad \text{(3b)} \end{array} \right.$$

Pressures are calculated from successive solutions at differing depths using the unsteady Bernoulli equation:

$$\frac{p - p_\infty}{\rho} = \frac{\partial\phi}{\partial t} - \frac{1}{2} (\nabla\phi)^2 \tag{4}$$

This equation must be case in body fixed coordinates since ϕ is calculated at the same point on the body in successive steps. Thus, equation (4) becomes:

$$\frac{p - p_\infty}{\rho} = \frac{\partial\phi}{\partial t} - \bar{V}_E \cdot \nabla\phi - \frac{(\nabla\phi)^2}{2} \tag{5}$$

The above problem can be put in nondimensional form by applying the following transformations:

$$\begin{array}{c} \hat{\phi} = \phi/V_I D \\ \hat{x},\ \hat{y},\ \hat{z} = x/D,\ y/D,\ z/D \\ \hat{h} = (\hat{\bar{V}}_p \cdot \bar{k}) C_w t V_I / D \\ \hat{V}_s = V_s/V_I \quad \hat{\bar{V}}_p = \bar{V}_p/V_I \quad \hat{\bar{V}}_E = \bar{V}_E/V_I \end{array} \tag{6}$$

Now equations (1) through (3) become:

$$\nabla^2\hat{\phi} = 0 \tag{7}$$

$$-(\nabla\hat{\phi})\cdot\bar{e}_n = \bar{e}_n \cdot \hat{\bar{V}}_E \tag{8}$$

$$\left.\begin{array}{l}\hat{V}_s = -(C_w-1)\hat{\bar{V}}_p\cdot\bar{k} \\ \hat{\phi} = 0\end{array}\right\} \text{ on effective planar surface} \tag{9}$$

The nondimensional pressure is:

$$C_p = 2\frac{\partial}{\partial t}\left[(\dot{\bar{V}}_p\cdot\bar{k})tC_w\right]\frac{\partial\hat{\phi}}{\partial h} - 2\hat{\bar{V}}_E\cdot\nabla\hat{\phi} - (\nabla\hat{\phi})^2 \tag{10a}$$

For constant entry conditions (i.e., $\bar{V}_p$ and C_w are fixed) the above becomes:

$$C_p = 2C_w\sin\theta\,\frac{\partial\hat{\phi}}{\partial h} - 2\,\bar{e}_v\cdot\nabla\hat{\phi} - (\nabla\hat{\phi})^2 \tag{10b}$$

These two equations indicate that the calculated pressure and force coefficients are independent of the model and entry velocity scale (i.e., D and V_I respectively). The value of these two parameters must be simulated through an appropriate choice of C_w. Also it is evident that for constant entry conditions, depth, not time is the most natural independent variable.

The boundary conditions used in the current study are similar to the linearized version applicable to slender bodies. The linearized conditions are that:

$$\phi = 0 \quad \text{on} \quad z = 0 \tag{11}$$

$$\bar{V}_s = -\frac{\partial\phi}{\partial z}(x,y,0)\,\bar{k} \tag{12}$$

These conditions follow from the nonlinearized form by dropping the quadratic terms which are second order as long as ϕ and its derivatives are small near the surface. The present model applies an empirical correction to the surface velocity described by equation (12).

POTENTIAL FLOW SOLUTION

At each depth the problem requiring solution is described by equations (7) through (9) and is directly amendable to the potential flow techniques developed by Hess and Smith which use a distribution of sources and sinks. The surface of the body under consideration is divided into quadrilaterals and a constant source strength is assumed to exist throughout each element. The source strengths are determined by satisfying equation (8) at the centroid of each element which results in a system of N simultaneous equations of the form:

$$\sum_{j=1}^{N} A_{ij}\,\sigma j = \bar{V}_E \cdot \bar{e}_{n_i} \tag{13}$$

Here σj is the source strength of element j, $\bar{e}_{n_i}$ is the unit vector normal to element i, and A_{ij} is the normal velocity induced on element i by unit source strength on element j. Equation (13) is solved directly using the method of reference 12. When the number of elements exceeds 120, solution is accomplished using a series of blocks.

Once the source strengths are determined, the velocity and potential at the centroid of each element can be calculated:

$$V_{\xi_i} = \sum_{j=1}^{N} B_{ij}\, \sigma j$$

$$V_{\eta_i} = \sum_{j=1}^{N} C_{ij}\, \sigma j \qquad (14)$$

$$\phi = \sum_{j=1}^{N} D_{ij}\, \sigma j$$

$$V_{\gamma i} = \bar{e}_v \cdot \bar{e}_{n_i}$$

Here B_{ij}, C_{ij}, and D_{ij} represent the quantities V_ξ, V_η and ϕ induced on element i by element j assuming element j has a source strength of one. The term of matrices [A], [B], [C], and [D] are evaluated using the closed-form expressions given in reference 11 which are reproduced in Appendix A. Equations (13) and (14) are cast in the inertial frame of reference where $V_\infty = 0$.

In applying the above method to the water-entry problem, only the submerged portion of the body (i.e., below the effective planar surface) is considered. The extra condition, $\phi = 0$, is satisfied on the effective planar surface by locating image elements above this surface as shown in Figure 2. The strength of the image element is equal in magnitude but opposite in sign to the original one.

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[12] Forsythe, G., and Moler, C., Computer Solution of Linear Algebraic Systems, Prentice-Hall, Englewood Cliffs, NJ, 1967

If the entry body possess symmetry about the y'-z' plane, only half of the model is gridded since symmetric element pairs have the same source strength. For such a body, four types of elements have the same source strength magnitudes and their influence coefficients are grouped together. The terms A_{ij}, B_{ij}, C_{ij} and D_{ij} reflect the influence on element i of element j, its image, the corresponding symmetric element and its image. If the entry body does not possess planar symmetry the entire face must be gridded. Here each influence coefficient reflects only the effect of an element and its image.

COMPUTATIONAL PROCEDURE

A series of points or nodes are defined on the surface of the body of interest in x', y', z' coordinates. These are arranged into groups of four to form planar quadrilateral elements as shown in Figure 3. The several different options available for defining nodes and elements on arbitrary bodies are discussed in Appendix C.

Solution of the Potential Problem

The entire body may have an aribtrary entry velocity and rotation in the y-z plane is allowed. The computation proceeds by inserting the model into the water in a series of steps each at a depth greater than the previous one. The entry velocity and the increment in model depth can be varied from step to step. At every step the group of elements comprising the submerged portion of the model are redefined and arranged into a form amenable to the calculative procedure outlined in the previous section. The nodes defining a particular element are checked to determine whether they are above or below the water line. Elements with all four nodes above the water line are discarded while those with all four below it are included without change. Element which are intersected by the water surface may have either one, two or three submerged nodes as shown in Figure 4. In all cases two new nodes are generated. Given two nodes, one below the water surface (x_1, y_1, z_1) and one above it (x_2, y_2, z_2) the new node located at the water surface on a line intersecting these two points is:

$$
\begin{aligned}
z_{new} &= 0 \\
y_{new} &= y_1 + (y_2 - y_1)\,\frac{z_1}{(z_1 - z_2)} \qquad (15) \\
x_{new} &= x_1 + (x_2 - x_1)\,\frac{z_1}{(z_1 - z_2)}
\end{aligned}
$$

When an element has only one node submerged, it is necessary to define a third new node in order to obtain a quadrilateral element. This last new node is placed midway along the surface edge of the element. If only one node is above the water surface the generation of two new nodes results in a pentalateral element. Here again, a third new node is added and the element is broken into two parts each of which is now quadrilateral.

It is necessary to define a set of element coordinates associated with each quadrilateral element used in the computations. This η, ξ, γ coordinate system is shown in Figure 5 and the corresponding unit vectors are as follows:

$$\bar{e}_\xi = \frac{(x_3-x_1)\bar{i} + (y_3-y_1)\bar{j} + (z_3-z_1)\bar{k}}{\sqrt{(x_3-x_1)^2 + (y_3-y_1)^2 + (z_3-z_1)^2}}$$

$$\bar{e}_\gamma = \frac{\bar{e}_\xi X[(x_2-x_4)\bar{i} + (y_2-y_4)\bar{j} + (z_2-z_4)\bar{k}]}{|\bar{e}_\xi X[(x_2-x_4)\bar{i} + (y_2-y_4)\bar{j} + (z_2-z_4)\bar{k}]|} \tag{16}$$

$$\bar{e}_\eta = \bar{e}_r X \bar{e}_\xi$$

Here the subscripts refer to the corner numbers shown in Figure 5.

At every step, equations (1) to (3) are solved using the potential flow method discussed in the last section. The value of the velocity and potential at each element centroid is stored for future use in determining C_p. In the case of elements which have been split into two (Fig. 4c), a single area weighted average value is retained.

Calculation of Surface Pressures

At each depth the pressure coefficient, C_p, is evaluated at each element centroid using equation (5) which is in a body fixed frame of reference:

$$C_p = \frac{p-p_\infty}{\frac{1}{2}\rho V_I^2} = \frac{2}{V_I^2}\frac{\partial\phi}{\partial t} + \frac{2\bar{V}_E\cdot\bar{V}}{V_I^2} - \left(\frac{V}{V_I}\right)^2 \tag{17}$$

The fluid velocity, $\bar{V}$, which appears in this equation is directly determined at each depth, but $\frac{\partial\phi}{\partial t}$ must be calculated using the value of ϕ at the same body locations in adjacent steps. The general expression used to calculate this quantity at the n^{th} step is:

$$\left.\frac{\partial\phi}{\partial t}\right|_n = \mathring{\phi}_{n-1} + (\mathring{\phi}_{n+1} - \mathring{\phi}_{n-1})\frac{\Delta t_{n-1}}{[\Delta t_{n+1} + \Delta t_{n-1}]}$$

$$\mathring{\phi}_{n-1} = \frac{\phi_{c_n} - \phi_{c_n - 1}}{\Delta t_{n-1}} \tag{18}$$

$$\mathring{\phi}_{n+1} = \frac{\phi_{c_{n+1}} - \phi_{c_n}}{\Delta t_{n+1}}$$

Here ϕ_{c_n} is the value of the potential at the element centroid where the pressure is being calculated at the n^{th} step. The quantity Δt_{n-1} is the time interval between steps n-1 and n. Similarly, Δt_{n+1} is the time interval between steps n and n+1. Note that if $\Delta t_{n-1} = \Delta t_{n+1}$, the above expression reduces to the central difference.

$$\left.\frac{\partial\phi}{\partial t}\right|_n = \frac{\phi_{c_{n+1}} - \phi_{c_{n-1}}}{2\Delta t_{n+1}} \tag{19}$$

Special problems arise in calculating $\left.\frac{\partial\phi}{\partial t}\right|_n$ for elements which are modified (i.e., intersected by the water surface) in any of steps n-1, n, and n+1. This is because the body fixed coordinate of a modified element centroid differs from its unmodified value and hence ϕ is not known at the same point on the body surface for the required number of adjacent steps. To handle this situation local similarity is assumed. This assumption holds that at any point within an element ϕ is only a function of the length of time that this point has been submerged. This removes the necessity of knowing ϕ at the same point on the body surface. Hence the values of ϕ associated with the same element centroid are used in equation (18) regardless of whether the element is modified in any of the three required adjacent steps. If an element is modified, the associated time interval between it and preceeding or following steps to be used in equation (18) is no longer the time interval between successive steps. The required time interval to be used in place of Δt_{n-1} is:

$$\Delta t = \frac{h_n - h_{n-1}}{C'_w V_z} \tag{20}$$

An analogous expression applies for determining Δt_{n+1}. Here h_n is the depth of the element centroid at step n while C'_w and V_z are the wetting factor and the z velocity component of the element centroid between steps n-1 and n. Since the model may rotate in the y-z plane the velocity vector of different points on the body surface will vary with location. Hence, the wetting factor C'_w used in equation (20) is a local value and not that prescribed for the entry body. Between steps n-1 and n this parameter is calculated from:

$$C'_w = \frac{V_z + (\bar{V}_p \cdot \bar{k})(C_w - 1)}{V_z} \tag{21}$$

where C_w is the prescribed time interval and wetting factors between n-1 and n. An analogous expression is used to determine C_w between steps n and n + 1.

For modified elements located near the water surface it is also possible to use the boundary condition $\phi_{n-1} = 0$ at $h_{n-1} = 0$. This condition must be applied if the element at which the pressure is to be calculated is not present in the preceding step (i.e., no part of it was submerged). It has also been found advantageous to use this condition for elements modified in step n.

The local similarity assumption is strictly applicable for the oblique entry under constant velocity and orientation of an infinite plate. For plates of infinite length but finite and constant cross-sectional geometry this assumption holds in x = constant planes shown in Figure 6. This assumption is well founded for bodies where conical similarity is applicable if for successive steps $\Delta h << h$. On three-dimensional models this assumption is most accurate on portions of the model where the surface geometry varies slowly.

The pressure coefficient on the model at the water surface is singular. This can be seen by casting equation (4) in a frame of reference moving with the effective planar surface.

$$C_p = \frac{2}{V_I^2}\left[\frac{\partial\phi}{\partial t} + V_s \cdot V - \frac{(V)^2}{2}\right]$$

On this surface $\frac{\partial\phi}{\partial t} = 0$. Due to a source discontinuity at the intersection of the model and the water surface $V \to -\infty$ and $C_p \to -\infty$. Fortunately, the value of C_p recovers quickly with depth and assumes a positive value well before the experimentally observed pressure peak. For the element sizes used in this study the first value of pressure calculated for each element is usually positive.

Negative C_p values can also be obtained on the sides of the entering body if allowance is not made for the flow cavity. Such values are set to zero for the purposes of calculating total model loads.

USE OF THE NUMERICAL MODEL

In using the described numerical model it is necessary to specify the wetting factor, C_w, the increment in depth between successive steps (Δh) and to construct an appropriate grid. In some cases it is also advisable to apply a correction to the pressure calculated on modified elements. The parameter C_w can be determined from a body of existing experimental data which will be reviewed in conjunction with specific applications. The numerical effect on C_{D_∞} and C_p of varying C_w is illustrated in Figures 7 and 8 respectively.

With decreasing values of C_w, C_{D_∞} is reduced in magnitude and peak values occur at a later time. The peak pressure coefficient increases with increasing values of C_w, but its rate of decay is also accelerated.

Selection of Δh

The flow field properties at any particular depth are independent of solutions at other depths and hence of Δh. However, calculation of C_p, as discussed in the previous section, requires values of ϕ from adjacent steps. In as much as the present method calculates only a single pressure for each element, it is desirable that this pressure represent an average for the element. To ascertain an appropriate step size for accomplishing this, the constant velocity and orientation entry of the flat plate of finite length shown in Figure 6 is considered. Defining $\bar{h}$ to be the depth of an arbitrary point p on the surface of the plate:

$$\left.\frac{\partial\phi}{\partial t}\right|_p = \frac{\partial\bar{h}}{\partial t}\left.\frac{\partial\phi}{\partial\bar{h}}\right|_p = C_w \sin\theta V_I \left.\frac{\partial\phi}{\partial\bar{h}}\right|_p$$

Transforming the above into the x", y", z" coordinate system of Figure 6 which is fixed on the effective planar surface:

$$\left.\frac{\partial\phi}{\partial t}\right|_p = (C_w \sin\theta V_I)\left[\frac{\partial\phi}{\partial y''}\,\frac{1}{\cos\theta}\right]_p$$

The average value of $\frac{\partial\phi}{\partial t}$ for the rectangular elements shown in Figure 6 with a pair of edges parallel to the water surface is:

$$\overline{\frac{\partial\phi}{\partial t}} = \frac{C_w \sin\theta V_I}{A\cos\theta}\int_{x_1''}^{x_2''}\int_{y_1''}^{y_2''}\frac{\partial\phi}{\partial y''}\,dy''dx'' = \frac{C_w \sin\theta V_I[\phi^*(\bar{h}_2) - \phi^*(\bar{h}_1)]}{(\bar{h}_2 - \bar{h}_1)} \tag{23}$$

or

$$\overline{\frac{\partial\phi}{\partial t}} = \frac{\phi^*(t_2) - \phi^*(t_1)}{(t_2 - t_1)}$$

Here $\phi^*(t_1)$ and $\phi^*(t_2)$ are the average values of ϕ along the upper and lower edges of the element respectively, A is the element area, and t_2 and t_1 are the lengths of time that the lower and upper edges of the element have been submerged.

Equation (23) is of the same form as the central difference expression used in evaluating $\frac{\partial\phi}{\partial t}$ (equ. (19)). If the pressure on the rectangular element of Figure 6 is being evaluated at step n, equations (19) and (23) become identical if the step size is chosen such that at step n-1 and n+1 the element centroid lies at the top and bottom edges of the element in step n respectively. Hence the step size should be chosen so that each element is completely submerged in two steps or

$$\Delta h = (y_2{}^1 - y_1{}^1)\cos\theta/2$$

The preceeding analysis is not strictly applicable to three-dimensional bodies entering with variable velocity and orientation and composed quadrilateral elements with edges not necessarily parallel to the water surface. However, it is taken as a guide and Δh is picked to insure that the average element is submerged in two steps. Thus,

$$\Delta h \sim \ell \cos \theta'/2 \qquad (24)$$

where ℓ is the element characteristic length and θ' is the typical element orientation angle with respect to the vertical. This criteria is easily applied on flat plates or cones. Spheres and other bodies with curvature in the axial direction are more difficult to deal with. The above is satisfied only approximately with elements perpendicular to the direction of motion being most heavily weighted. In practice, it is these elements which experience the largest pressures and hence are most crucial to the problem solution. On bodies with curvature in the axial direction the size of the elements is increased as their orientation approaches the direction of motion.

The effect of varying grid size and hence Δh on C_{D_∞} and C_p is illustrated in Figures 9 and 10 respectively. On flat surfaces an accurate solution is obtained with only a small number of elements. The principal effect of increasing the number of elements is to reduce the peak calculated pressure. Since these peak pressures act over small areas the drag coefficient is relatively insensitive to increases in the number of elements. More complex shapes naturally require the use of a larger number of elements.

Describing the Entry Body with Quadrilateral Elements

In setting up a grid, best results are obtained if the afterbody is neglected and only the nose of the entering body is gridded. The pressures and source strengths on afterbody elements are small. On models with well rounded shoulders exclusion of these elements decreases the required computational effort without strongly effecting the solution. On models with sharp edges such as disk cylinders, inclusion of the afterbody elements imposes the requirement that the flow make a sharp turn about the edge of the face. This requirement is physically unrealistic since the flow will separate at the face edge. Use of afterbody elements in this case increases the flow velocity on elements near the edge which in turn decreases the calculated pressures. This is illustrated in Figures 11 and 12 which give the calculated drag for the oblique entry of a disk cylinder with and without afterbody element respectively. Results obtained in Figure 12 without the use of afterbody elements are in much closer agreement with experimental results and required a smaller amount of computational effort.

Cavity Modeling Using No Load Elements

At time following peak impact loading the existence of the flow separation region or cavity about the afterbody of entry models may have a significant effect on the model surface pressures and positive steps must be taken to model it.

Accordingly, no load elements have been introduced into the computations. These elements are placed on the water-cavity interface and their purpose is to force the flow to attain the correct streamlines in this vicinity. Loads on these elements are not included in the drag and lift totals for the entry body.

No load elements are placed on a surface extending from the position on the model where separation occurs to the effective planar surface. The actual location of each element is adjusted in successive runs until the pressures on it is at a desired level ($C_p = 0$ for a vented cavity). Typical results for a disk cylinder are shown in Figure 13 assuming a vented cavity. In this case the cavity was modeled using a single ring of elements extending from the edge of the face to the effective planar surface. Although the procedure for locating the no loads elements is not automated and therefore somewhat tedious, the results do account for much of the difference between experiment and theory. Fortunately, it is generally not necessary to include the cavity at times prior to the peak load.

Correcting Pressure on Modified Elements

During the vertical entry of axisymmetric bodies it is appropriate to apply a correction to the pressures calculated on modified elements. Under these conditions the body is gridded with elements having a pair of sides parallel to the water surface. Following the step size rule of equation (24) elements are submerged in exactly two steps. On odd numbered steps the elements adjacent to the water surface are all modified while in even numbered ones they are not modified. Apparently, the pressure levels predicted in the odd steps are not consistent with those calculated in the even ones. This is illustrated by considering the vertical entry of a 22.5, 45 and 70 degree half-angle cones. The drag coefficients, non-dimensionalized by the local surface diameter, are given in Table 1 as a function of depth. Since this problem is conical in nature the drag should be the same at each depth. For the first few steps error may be expected since the entire cone is being modeled with only a few elements. However, results should converge to a common value. It is clear from Table 1 that the odd and even number steps are converging to different values. In order to determine the better of the two answers, calculated pressure distributions are compared to experiment for typical odd and even numbered steps in Figures 14 and 15. These pressure distributions are very similar except near the water surface. Figure 14 clearly shows that the pressure on the modified element is too large. A simple correction factor, F_c, can be determined which when multiplied by the pressure on the modified element brings the total drag calculated in even and odd steps into line with one another. The value of this correction factor has been plotted in Figure 16 as a function of depth for the three different cones under consideration.

When applying the present model to the vertical entry of axisymmetric bodies, either the drag calculated in odd numbered steps should be ignored or the correction factor F_c should be used. In the remainder of this report a value of .67 is used.

The above problem does not arise during oblique entry since the edges of the generated elements are not parallel with the water surface and the number of modified elements is fairly constant from step to step. This does not mean that such a correction is not necessary. However, there is no systematic method for chosing F_c on general bodies. Experience suggests that on slender bodies (nose length/D >1) a value of .67 should be used and in all other oblique entry cases F_c should be set to unity.

APPLICATION OF THE CODE TO SPECIFIC EXAMPLES

The previously described computer program has been applied to the oblique entry of disk cylinders, ogives, spheres, and to the vertical entry of ogives, cusps, cones, and spheres. In this section these calculations are compared to experimental results. In assessing the validity of the water-entry model it should be kept in mind that some uncertainty exists with regard to many of the experimentally determined quantities. Also, measured quantities may not be equivalent to calculated ones. The measured pressure represents the value at a specific point on the model while the calculated result reflects the average for an element of finite size. These two quantities become synonymous on elements well below the water surface.

Vertical Entry of Axisymmetric Bodies

In this section the vertical entry of cones, cusps, spheres, and ogives is considered. The two-dimensional nature of these problems insures that a single value of C_w accurately characterizes the rate of surface wetting about the entire perifery of the model. Also, separation of flow on cones and cusps can be categorically ruled out until after the shoulder of the model has entered the water. These cases thus provide an ideal opportunity for testing the proposed predictive method.

Vertical cone entry calculations are compared to the experimental results of Baldwin[13,14] which were taken at entry velocities of 16 to 32 ft/sec. Using a correlation developed in this work, an expression for the wetting factor can be obtained which is applicable to cones with a half angle greater than 7.5 degrees:

$$C_w = \frac{1}{[1. - .396\theta_c + .287\theta_c^{\,2} - .124\theta_c^{\,3}]} \qquad (25)$$

Here θ_c is the cone half angle in radians. Measured and calculated pressure coefficients on 22.5, 45, and 70 degree half-angle cones are shown in Figures 15, 17, and 18. The experimental values represent a correlation based on

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[13] Baldwin, J. L., An Experimental Investigation of Water Entry, PhD Dissertation, U. of Maryland, 1972

[14] Baldwin, J. L., "Vertical Water Entry of Cones," Naval Surface Weapons Center, White Oak Laboratory, NOLTR 71-25 (1971)

conical similarity which has been corrected to reflect a constant entry velocity. Use of normalized depth as the independent variable is appropriate since the computational model also produces conically similar results. Excellent agreement is obtained between calculations and experiment. In particular, predicted pressure coefficients reflect the reversal in functional form exhibited by the data with increasing cone angle. Experimental data near the tip of the cone is not shown since Baldwin has indicated that there were an absence of measurements in the region[15].

In Figure 19, the calculated drag of finite length cones are compared to Baldwin's results. Good agreement exists up to the point where the cone becomes completely submerged which coincides with the occurrence of peak drag. At later times the calculated values are too low. Improved agreement between experiment and theory would probably be obtained if the cavity were modeled.

The calculated drag on vertically entering cusps and ogives are compared to the experimental measurements of reference (16) in Figures 20 to 23. The dimensions of these bodies are given in their respective figures. Predicted values are in good agreement with experiment prior to the drag peak. To accurately determine the drag peak on the cusp models the grid was extended past the actual shoulder by one row of elements. The present calculative method anticipates the end of the cusp one step before it occurs making this procedure necessary (see Equ. (18)). At times following the point of peak drag, forces on the entry body are calculated both with and without a simulated cavity. In the cases depicted in Figures 20, 21, and 23, inclusion of the cavity brings the computed drag into close agreement with experiment. The formation of a cavity does not appear important for the ogive of Figure 22. This body is the slenderest of the four models with little surface discontinuity at the shoulder-afterbody junction.

A systematic method for determining C_w in the above four cases involves substituting the local body angle, θ_ℓ, into equation (25) to determine C_w as a function of time. It would seem plausible to use either the local angle on the effective planar surface or at the original surface. The validity of these two approaches can be examined for the cusp models where the peak drag can be assumed to occur as the shoulder of the model is wetted. The better of these two methods is the latter, but even it overpredicts C_w resulting in a premature wetting of the shoulder. A correction factor can be determined which

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[15] Baldwin, J. L. Private communication

[16] Baldwin, J. L., "Vertical Water Entry of Some Ogives, Cones, and Cusps", NSWC/WOL/TR 75-20, Mar 1975

produces the actual time of shoulder wetting when multiplied by the C_w factors calculated from equation (25) using θ_ℓ at the original surface. The results shown in Figures 20 and 21 reflect correction factor values of .97 and .94 respectively. Correction factor with values greater than unity might be postulated for ogives since their profiles are convex instead of concave. However, this type of adjustment was not carried out and the computations for the ogive models used the values of C_w defined by equation (25). Examination of Figures 22 and 23 indicates that such a correction would have reduced the discrepancy between theory and experiment.

Calculations for the vertical entry of a sphere are compared to Nisewanger's[17] experimental measurements. These tests were made at an entry velocity of 23.5 ft/sec. Pressures were measured at a number of points on the model surface and integrated to produce total drag. The response times of successive gages were used to give the following expression for the wetting factor:

$$C_w = 1.736 - .829\sqrt{t^*} \qquad (26)$$

Calculated pressures are compared to measured ones in Figures 24 through 26. Only the pressure measurements made while the transducers were fully wetted are shown. The predicted stagnation pressure is over estimated at early times but in good agreement otherwise. At intermediate distances from the stagnation point the predicted pressure is below the measured one. However, far from the stagnation point, as is shown in Figure 26, the calculated pressure is again close to experiment. The predicted drag is compared to experiment in Figure 27 with best agreement being obtained at early times. The measured drag does not account for model deceleration. However, these results are in good agreement with Mosteller's[18] constant velocity data.

Oblique Entry of Arbitrary Bodies

The oblique entry of arbitrary bodies constitutes a more rigorous test of the predictive method since these cases are three dimensional. Calculations are compared to experiment for cones, disk cylinders, spheres, and ogives.

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[17] Nisewanger, C. R., "Experimental Determination of Pressure Distribution on a Sphere During Water Entry", NAVWEPS Report 7808, Oct 1961

[18] Mosteller, G. G., "Axial Deceleration at Oblique Water Entry of 2-Inch-Diameter Models with Hemisphere and Disk-Cylinder Noses", NOTS NAVORD Rept. 5424, (1957)

Predicted and measured pressure distribution on a 45 degree half-angle cone entering vertically but at an agle of attack are shown in Figure 28. The experimental data are unpublished results of J. L. Baldwin of NSWC/WOL taken on the windward and leeward ray of the cone at incidences of 10 and 20 degrees. Equation (25) was used to determine C_w. On the windward ray the cone angle was incremented by the angle of attack while on the leeward side it was decreased by this amount. As can be seen from this figure, results are generally in good agreement with measurements.

Experimental data on the oblique entry of disk cylinders can be found in the work of Norman[19], Mosteller[18], and Baldwin[13], representing entry velocities of 25 to 325 ft/sec. Based on the latter two sources and data taken in the present study, a C_w value of 1.45 is selected for all entry angles. Existing information for this parameter, shown in Figure 29, contains extensive scatter and hence this choice is a rough estimate. In Figure 12, the calculated drag is compared to Baldwin's empirical correlation of experimental data. Both theory and experiment agree quite well over a wide range in entry angle. Calculated pressures are compared to Aronson's experimental data in Figure 30*.

In Figures 31 and 32 calculations are compared to Aronson's pressure measurements on a three-inch-diameter ogive cylinder entering obliquely at 100 ft/sec and an angle of 60 degrees. This body has a flat face, 1.5 inches in diameter, and rounded shoulders with radii of .75 inches. The mean measure C_w value of 1.36 is used in the computations. Experimental results indicate that pressures rise more quickly, to a higher peak and fall more rapidly on the lower portion of the model face. This is particularly evident for measurements made on the shoulder of the model. The computed results closely reflect this change in the pressure trace associated with transducer location. However, peak pressures are consistently overpredicted. Fortunately, the high peak pressures act on extremely small areas and thus have little effect on the actual load for the size elements being used. To illustrate this point, experimental and calculated loads on the computational element nearest to the center of the face are plotted in Figure 33. The experimental load is obtained by applying the data from location 1 in Figure 32. The pressure-time history of each point in the computational element is assumed described by this relation.

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[19] Norman, J. W., Burden, W. J., and Suter, R. A., "Deceleration at Water Entry-IV, The Effects of Velocity, Entry Angle and Pitch on a Projectile with a Flat Cylindrical Head", ARL/R5/G/HY/2/3, 1960

*A brief summary of this experimental work will soon be available from the National Technical Information Service in a report titled "Prediction of Surface Pressures During Water Impact" by Wardlaw and Aronson

In Figure 27 the calculated drag for the oblique entry of a sphere is plotted against experimentally smoothed curves given by May[5] which are constructed from the data of references (18), (20), (21), and (22). This information reflects entry velocities between 11 and 225 ft/sec. The wetting factor for the oblique entry of a sphere has not been extensively investigated. A value of 1.35 was selected based on White's[23] limited results. Reasonably good agreement is obtained between calculated and experimental values.

Calculated loads on a slender ogive body entering obliquely are compared in Figures 34 and 35 to the unpublished drag, normal force and pitching moment data by Baldwin. The wetting factor for this case does not appear to have been investigated experimentally. A value of 1.1 is used which corresponded to the average value obtained for the vertical entry of this body using equation (25). Best agreement between measurements and calculations occurred using the OGIVE grid option, discussed in Appendix C, which produces elements with a pair of edges parallel to the water surface. Consistent with previous discussion, the calculated loads at odd numbered steps are discarded. Analytical results are in closest agreement with experiment at the entry angle of 75 degrees as shown in Figure 35. The premature decrease in the calculated drag at $\theta = 45°$ in Figure 34 can probably be attributed to the formation of a cavity along the upper surface of the ogive. The use of no load elements to model the water-cavity interface could conceivably decrease this discrepancy. Consistent with trends visible in previous examples, the underprediction of the drag initially occurs near the point where the total load on the slender ogive model peaks.

The present calculative procedure does not include the contribution to normal force and pitching from the formation of an underpressure cavity. Hence in cases where this effect is important the calculated normal force and pitching moment will not be very accurate.

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[20] Hobbs, E. V., Breakstone, H. I., and Woodson, J. B., "Oblique Entry of Spheres into Water", NBS Rept. 2788 (1951)

[21] Hydroballistics Design Handbook, BuOrd NAVORD Rept. 3533 (1955)

[22] Norman, J. W., Burden, W. J., and Suter, R. A., "Deceleration at Water Entry-III, Velocity, Entry Angle, and Pitch Effects on a Projectile with a Hemisphere Head", ARL/R4/G/HY/2/3 (1959)

[23] White, F. G., "Photographic Studies of Splash in Vertical and Oblique Water Entry of Spheres", NAVORD Report 1228, 1950

SUMMARY AND CONCLUSIONS

This technical report outlines a systematic method for calculating surface pressures, forces and moments on arbitrary bodies during the early phases of water entry. A potential flow model is assumed and the free surface is approximated by an effective planar surface empirically located at the splash height. The computational techniques of Smith and Hess are used to solve the the potential problem. This requires that the surface of the body be described by planar quadrilateral elements. Using Bernoulli's equation the average pressure is calculated on each element and then integrated to produce total forces and moments on the entry body. Through the use of no load elements it is possible to model the cavity which form about the entry body, but this is generally not necessary.

The described method of calculation has been applied to a number of different cases in which experimental data is available. For vertical entry this includes cones with and without angle of attack, ogives, cusps, and spheres. The oblique entry case has been studied for disk cylinders, spheres, blunt and slender ogives covering entry angles between 30 and 90 degrees. The predicted pressure traces accurately duplicate experimental results, reflecting not only overall body geometry but also location on the body surface. The calculated loads are in good agreement with experimental values, particularly prior to the point of peak loading. At later times no load elements must be used to model the water-cavity interface.

Although the current predictive method is a viable engineering tool, some shortcomings are evident. Most notably, pressures on elements adjacent to the water surface are often overpredicted. This is not surprising considering the singularity which exists at the water surface in the current formulation. An empirical correlation scheme based on an experimental data correlation (e.g., reference (24)) might offer substantial improvement. Finally, it is clear from the studied examples that positive steps must be taken to model the cavity after the point of peak load. Provisions should be made for automating this procedure.

[24] Baldwin, J. L., and Steves, H. K., "Vertical Water Entry on Spheres", NSWC/WOL/TR 75-49, May 1975

TABLE 1 CALCULATE CONE DRAG AS A FUNCTION OF STEP NO. AT ODD NUMBER STEPS ELEMENT ADJACENT TO THE WATER SURFACE IS MODIFIED WHILE ON EVEN NUMBER STEPS IT IS NOT.

STEP NO. \ θ_c	22.5°	45°	70°
1	0.565	2.178	9.218
2	0.455	1.815	7.964
3	0.430	1.744	7.902
4	0.333	1.455	6.528
5	0.396	1.611	7.376
6	0.333	1.391	6.356
7	0.373	1.543	7.166
8	0.323	1.369	6.300
9	0.362	1.511	7.042
10	0.322	1.361	6.276
11	0.354	1.483	6.925
12	0.321	1.354	6.267
13	0.349	1.463	6.850
14	0.320	1.349	6.258
15	0.346	1.432	6.790
16	0.321	1.344	—

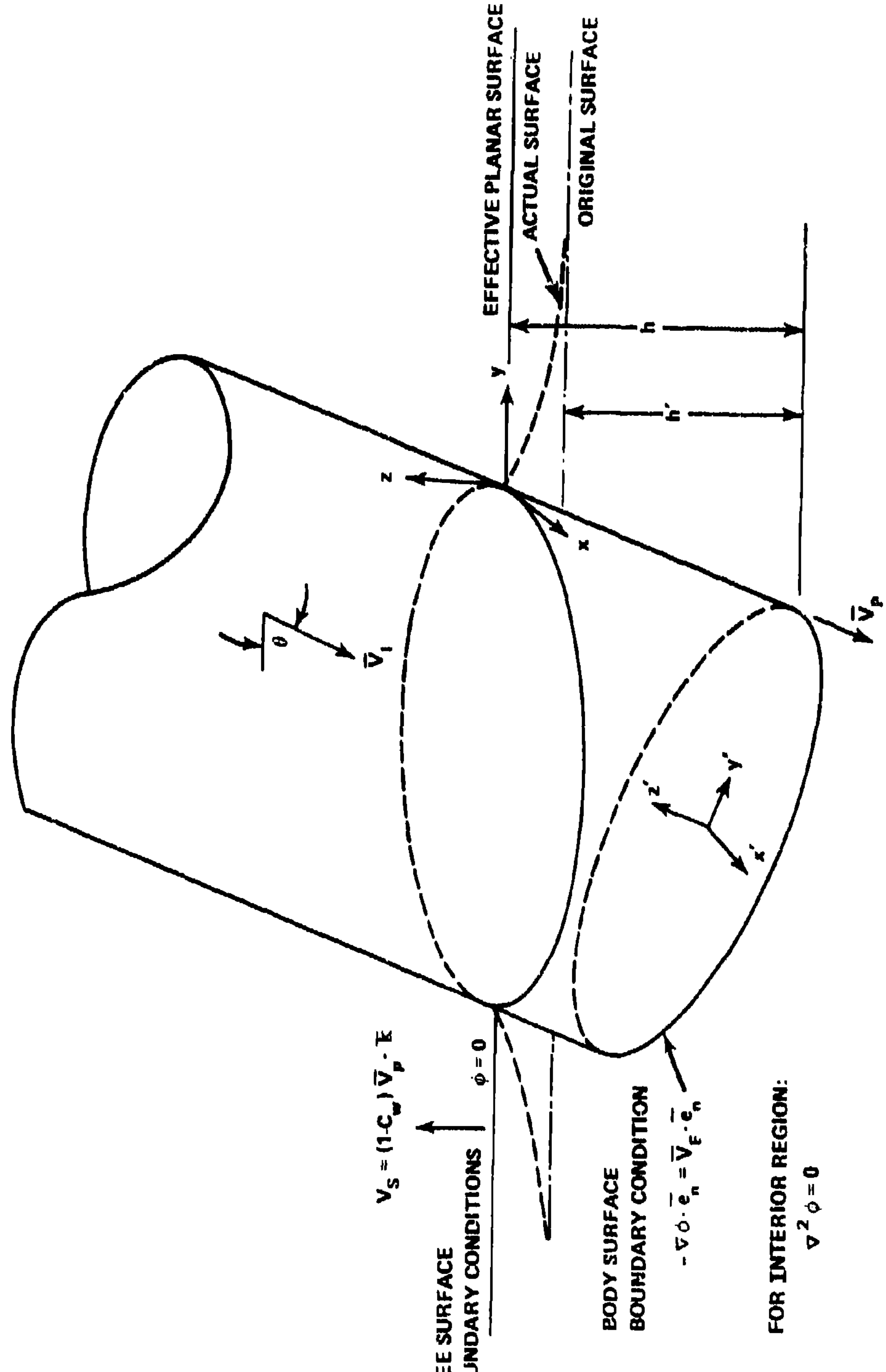

FIG. 1 PROBLEM FORMULATION

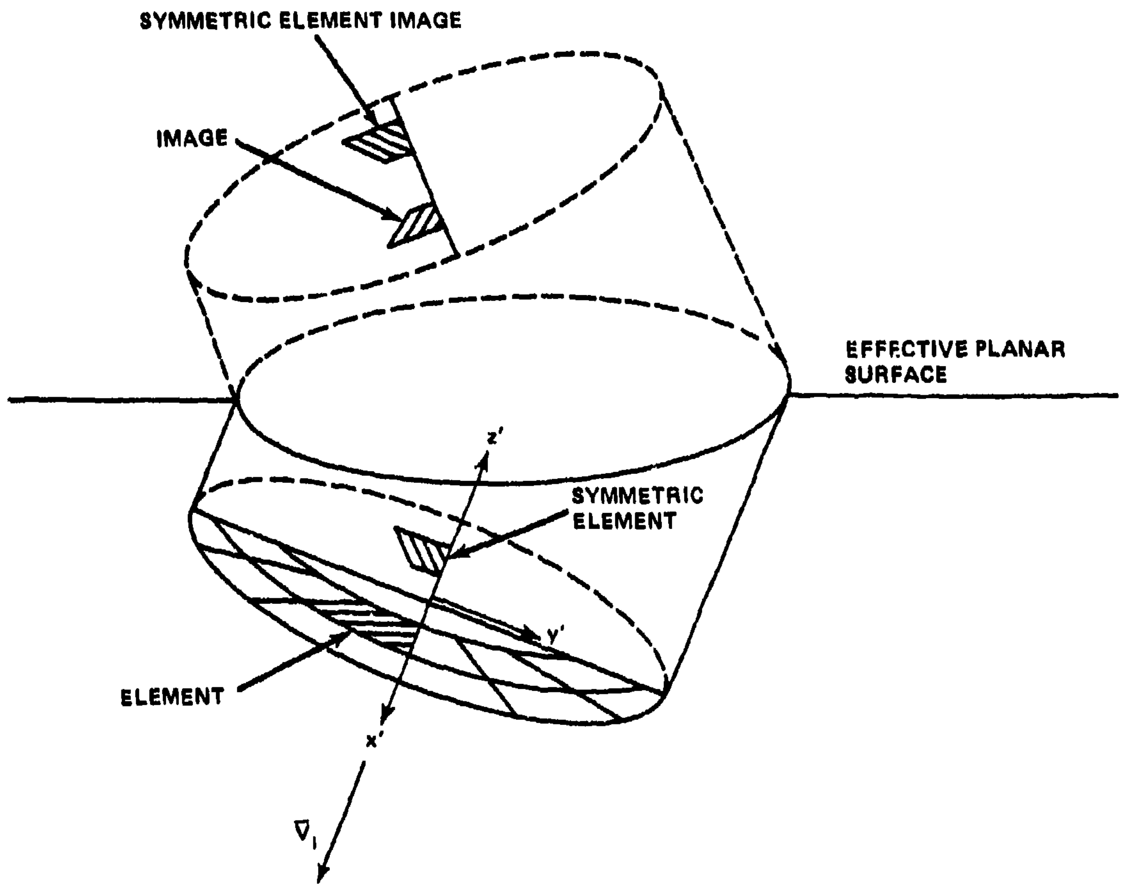

FIG. 2 ELEMENTS WITH SIMILAR SOURCE STRENGTHS. ONLY HALF OF A BODY WITH y' - z' PLANE IS GRIDDED. EACH ELEMENT HAS A CORRESPONDING SYMMETRIC, IMAGE AND IMAGE SYMMETRIC ELEMENT OF THE SAME SOURCE STRENGTH MAGNITUDE.

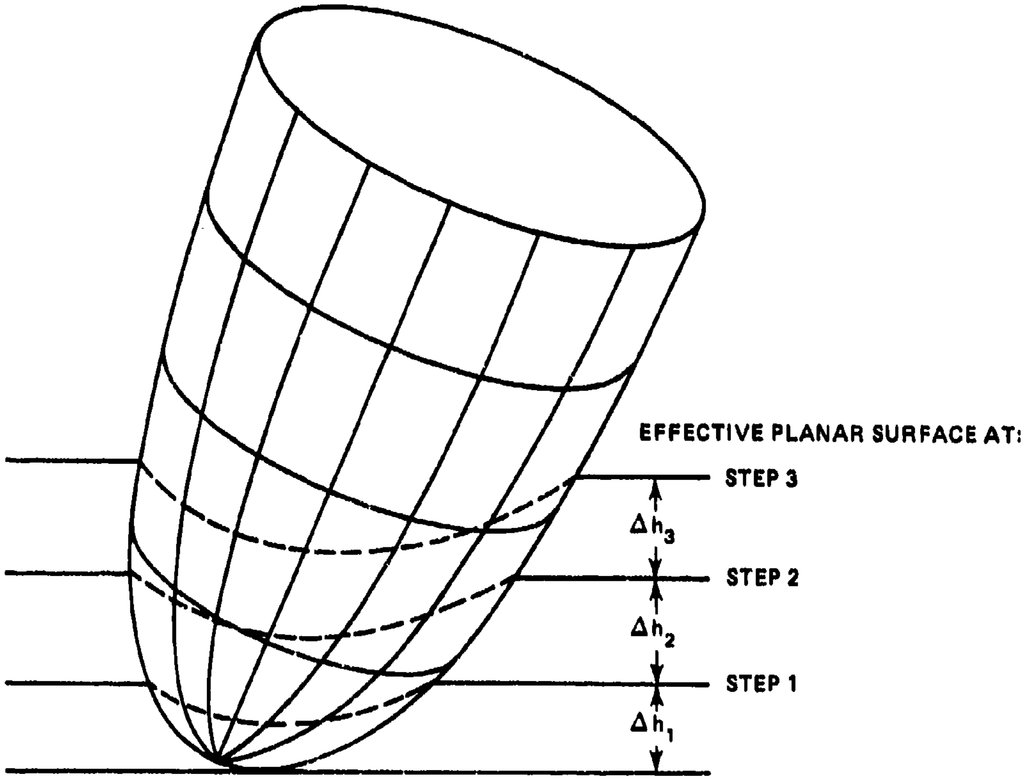

FIG. 3 COMPUTATIONAL GRID. THE MODEL SURFACE IS DIVIDED INTO PLANAR QUADRILATERAL ELEMENTS. ALSO SHOWN IS THE INTERSECTION OF THE WATER SURFACE AND THE MODEL DURING THE FIRST THREE STEPS.

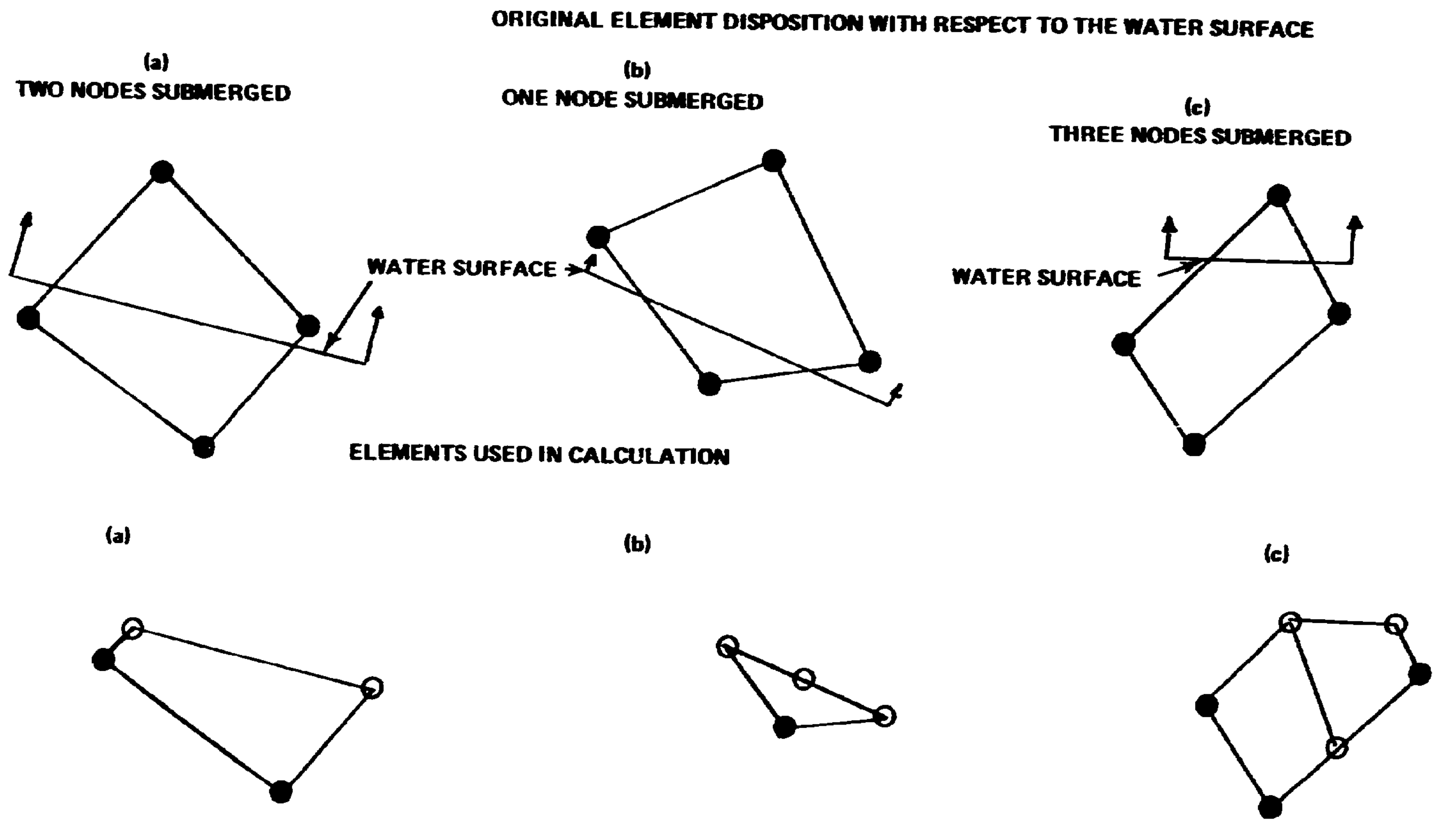

FIG. 4 ELEMENTS WHICH ARE INTERSECTED BY THE WATER SURFACE ARE REDEFINED. THE THREE POSSIBLE CASES WHICH CAN ARISE ARE DEPICTED. ● REPRESENT ORIGINAL NODES. ○ ARE THE GENERATED NODES LYING ON THE WATER SURFACE.

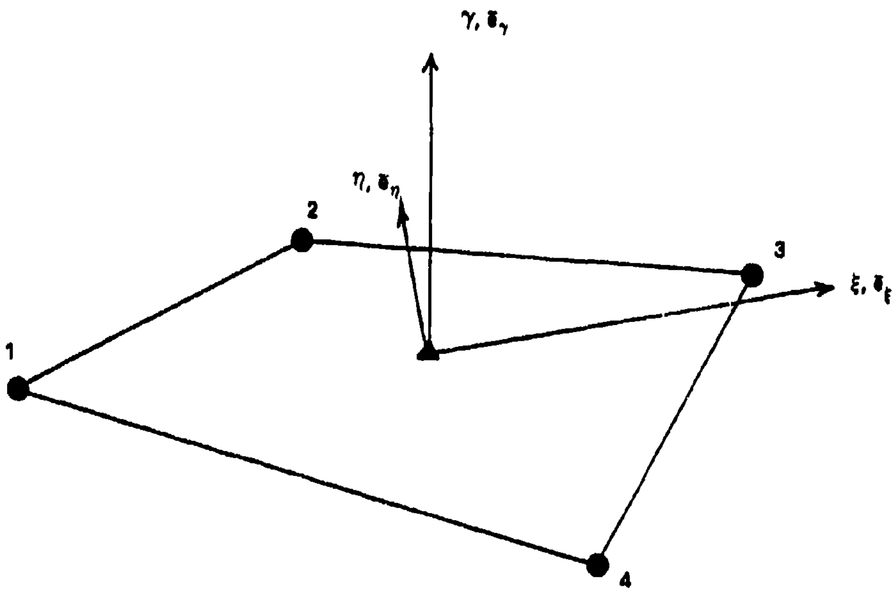

FIG. 5 THE NODES DEFINING EACH ELEMENT ARE ARRANGED IN CLOCKWISE ORDER. A ξ, η, γ COORDINATE SYSTEM IS DEFINED FOR EACH ELEMENT AND LOCATED AT THE ELEMENT CENTROIDE.

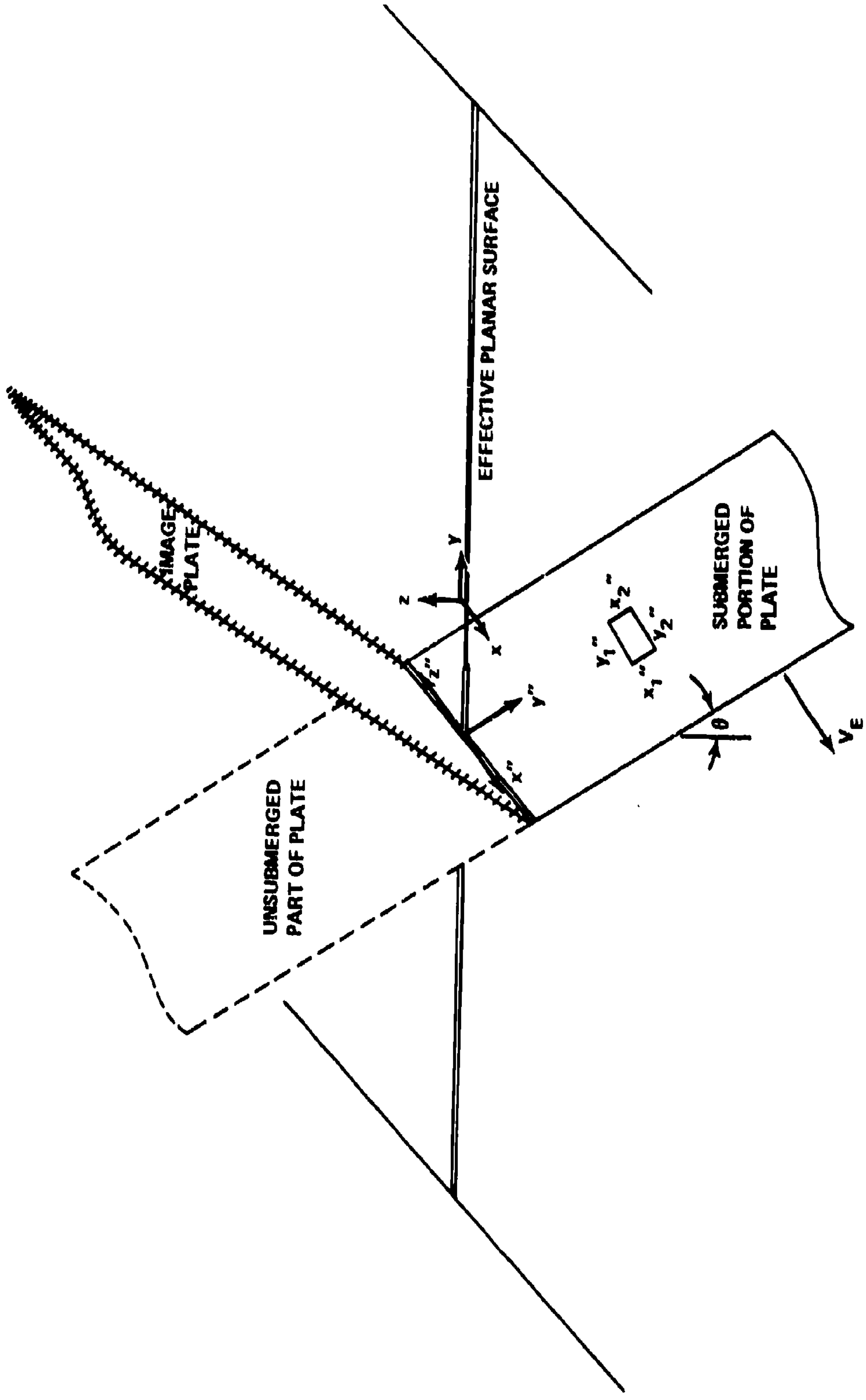

FIG. 6 PLATE OF FINITE WIDTH AND INFINITE LENGTH ENTERING THE WATER OBLIQUELY SUBJECT TO THE ASSUMED BOUNDARY CONDITIONS.

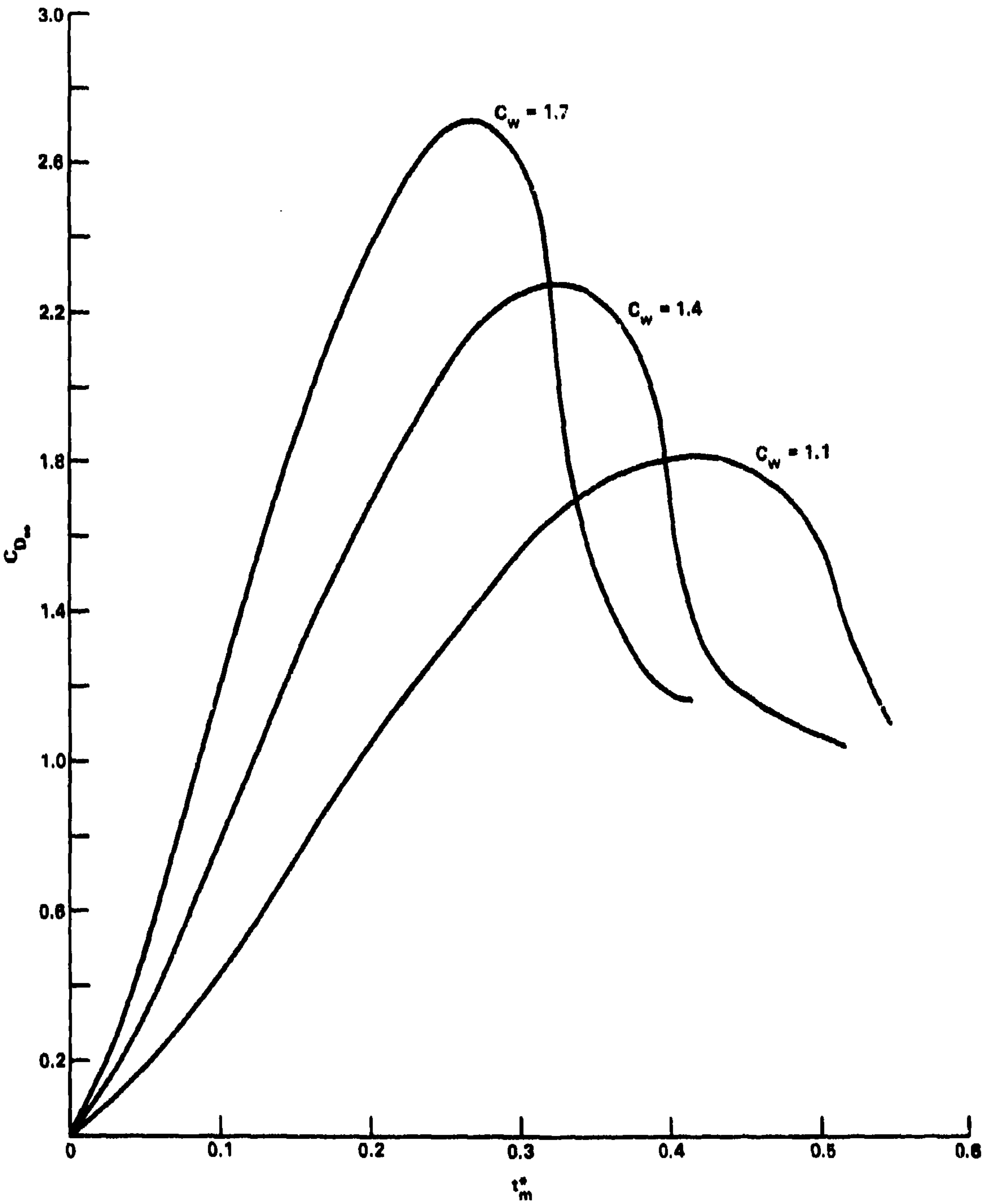

FIG. 7 DRAG OF A DISK AT AN ENTRY ANGLE OF 60 DEGREES AS A FUNCTION OF C_w.

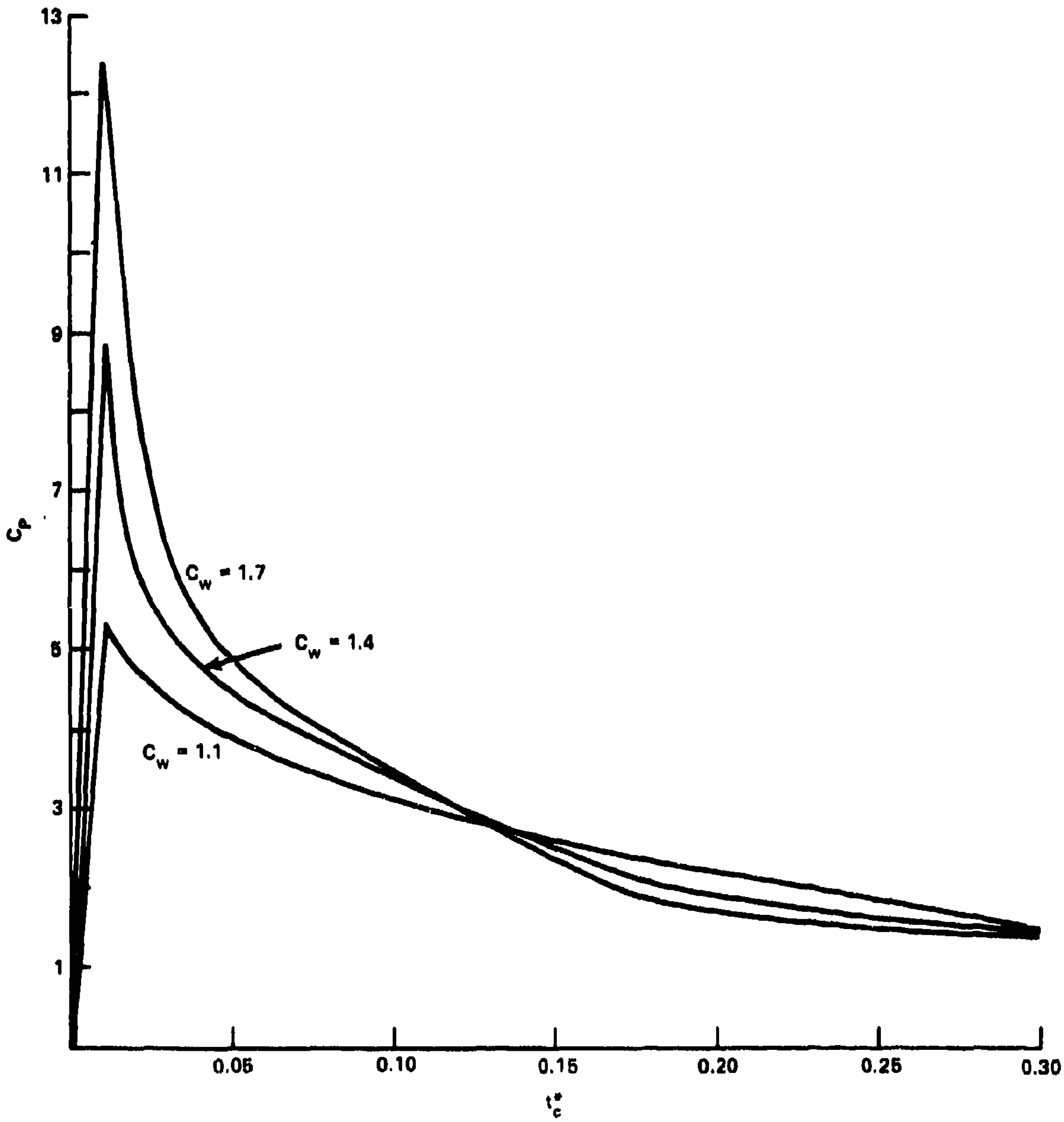

FIG. 8 PRESSURE COEFFICIENT AT THE CENTER OF A DISK CYLINDER ENTERING AT 60 DEGREES AS A FUNCTION OF C_w.

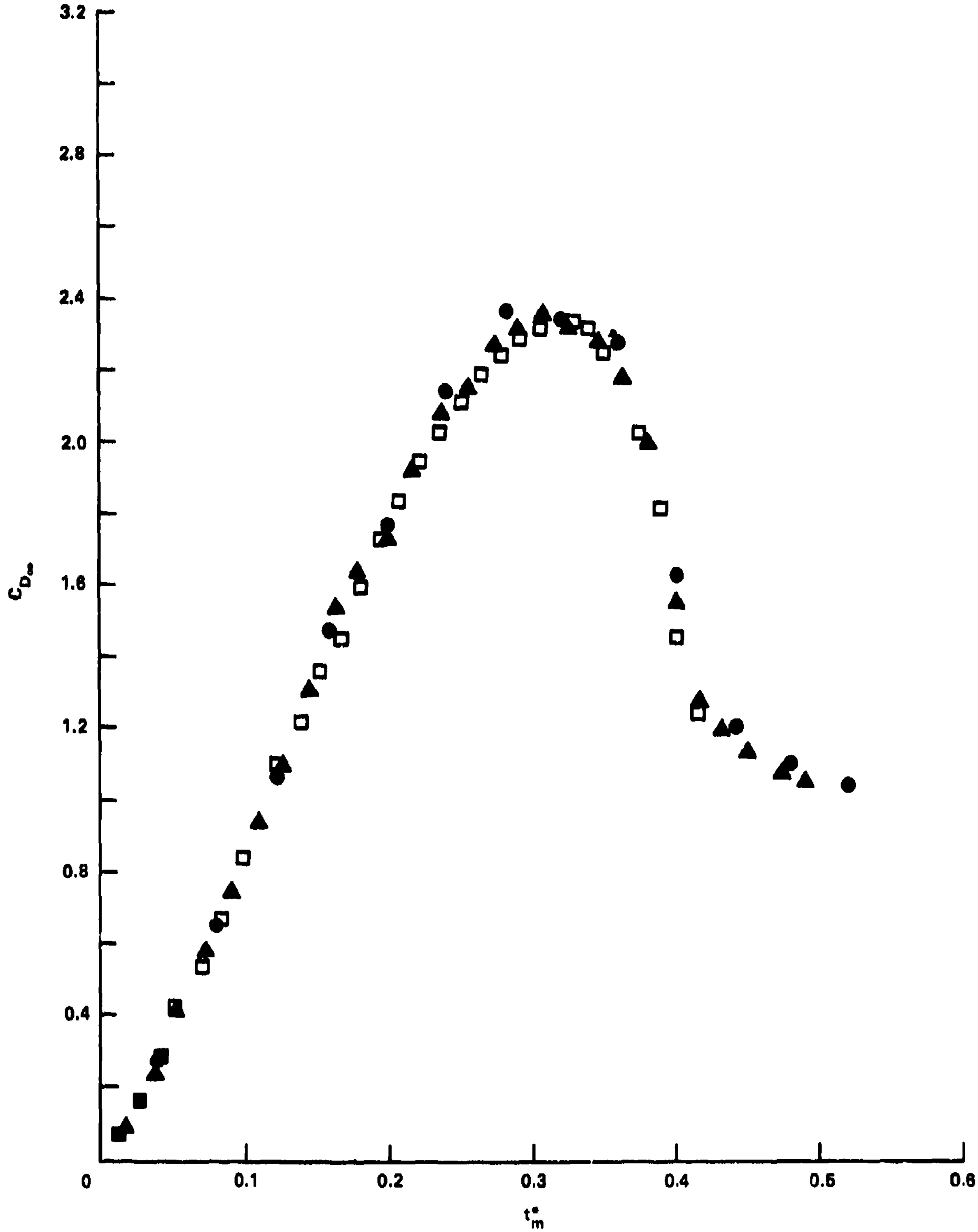

FIG. 9 THE EFFECT ON CALCULATED DRAG OF VARYING THE GRID SIZE. THE ENTRY BODY IS A DISK CYLINDER AT θ = 60 AND C_w = 1.45. ● 12 ELEMENT GRID ▲ 51 ELEMENT GRID □ 92 ELEMENT GRID.

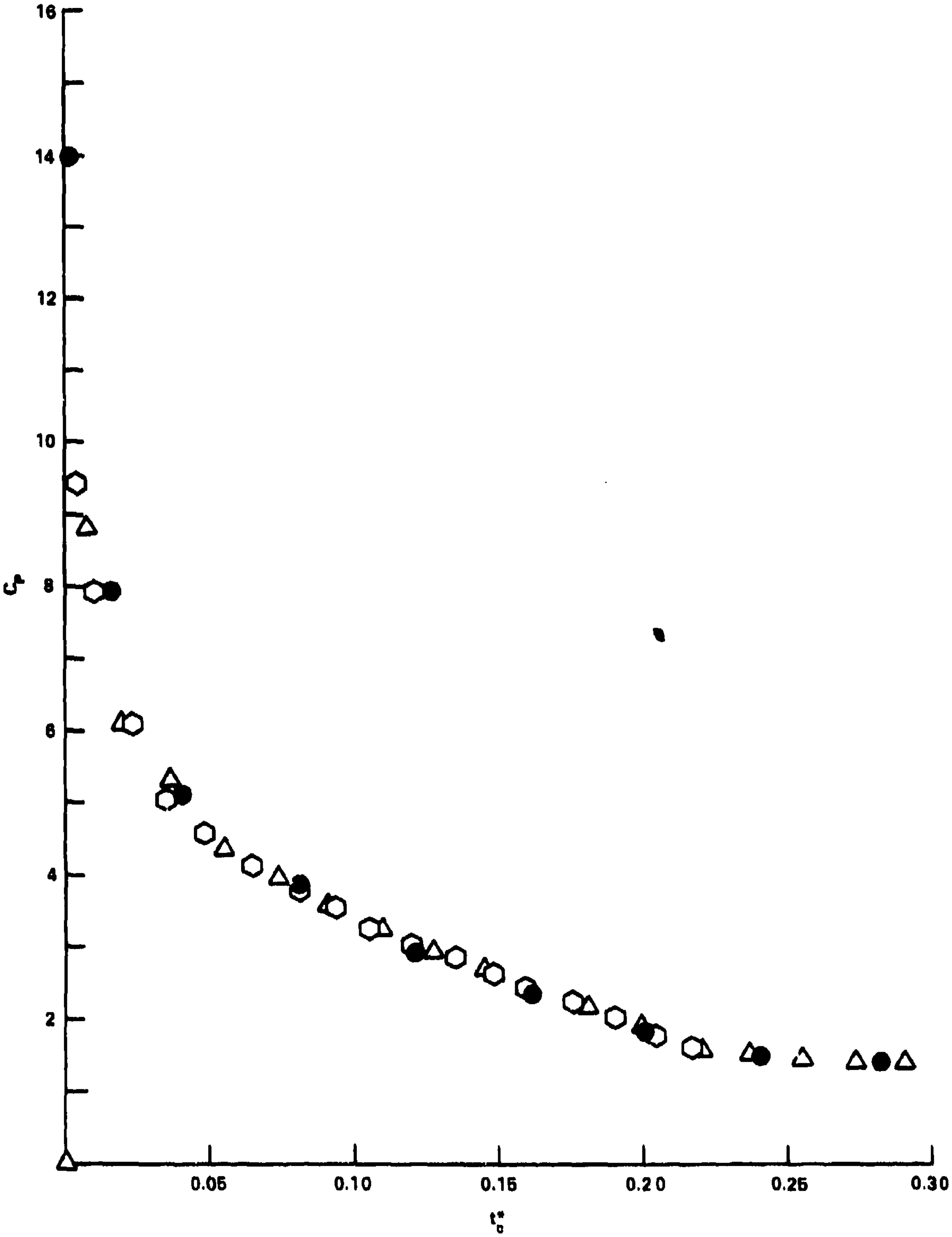

FIG. 10 THE EFFECT ON THE PRESSURE COEFFICIENT AT THE CENTER OF A DISK ENTERING OBLIQUELY AT $\theta = 60$ OF VARIOUS GRID SIZES. ● 12 ELEMENT GRID △ 51 ELEMENT GRID ○ 92 ELEMENT GRID

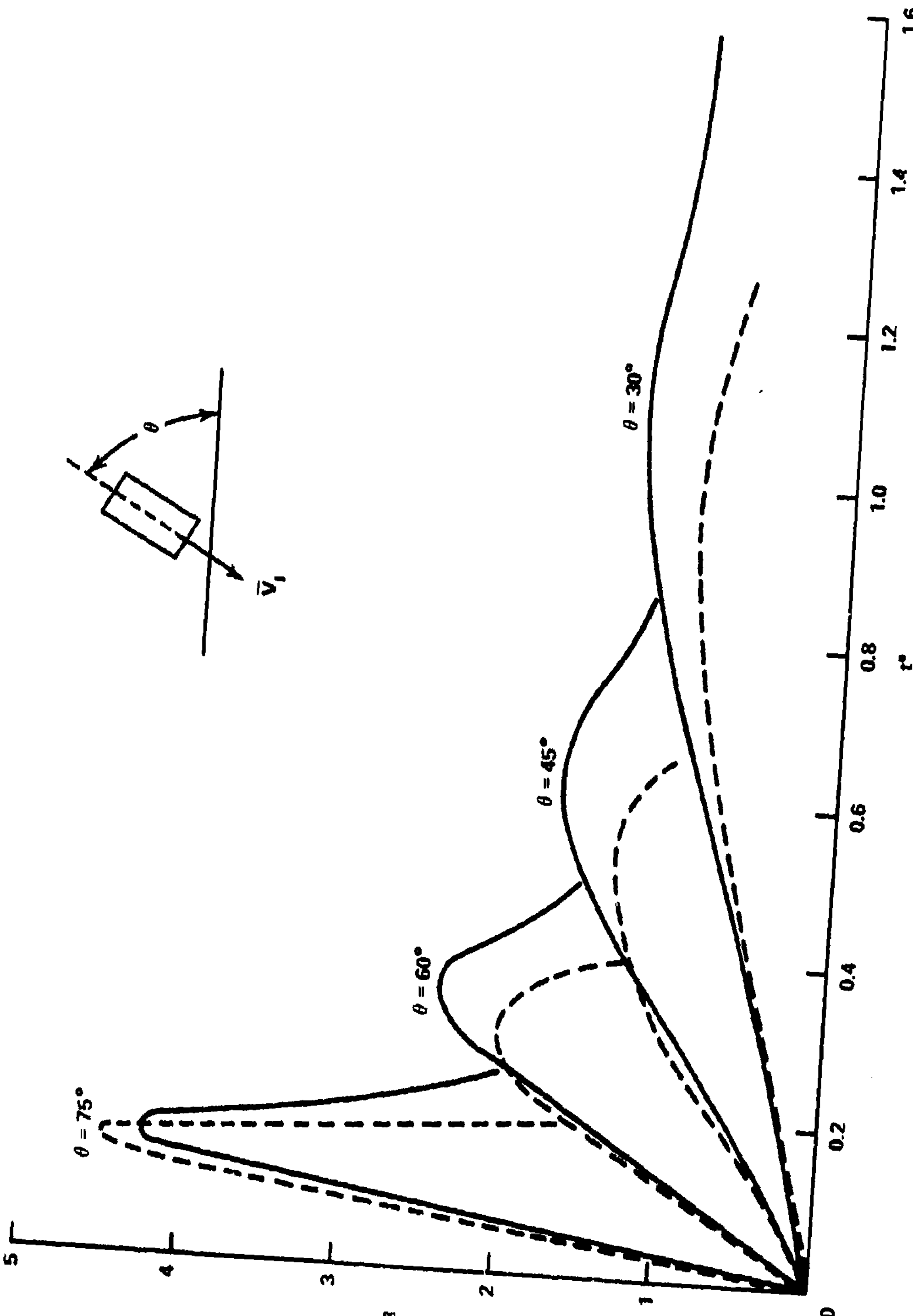

FIG. 11 PREDICTED AND MEASURED DRAG ON A DISK CYLINDER AT VARIOUS ENTRY ANGLES. —— EXPERIMENTAL DATA BY BALDWIN[13] – – – CALCULATED RESULTS WITH C_W = 1.45 AND USING A GRID COVERING BOTH THE NOSE AND AFTERBODY OF THE MODEL.

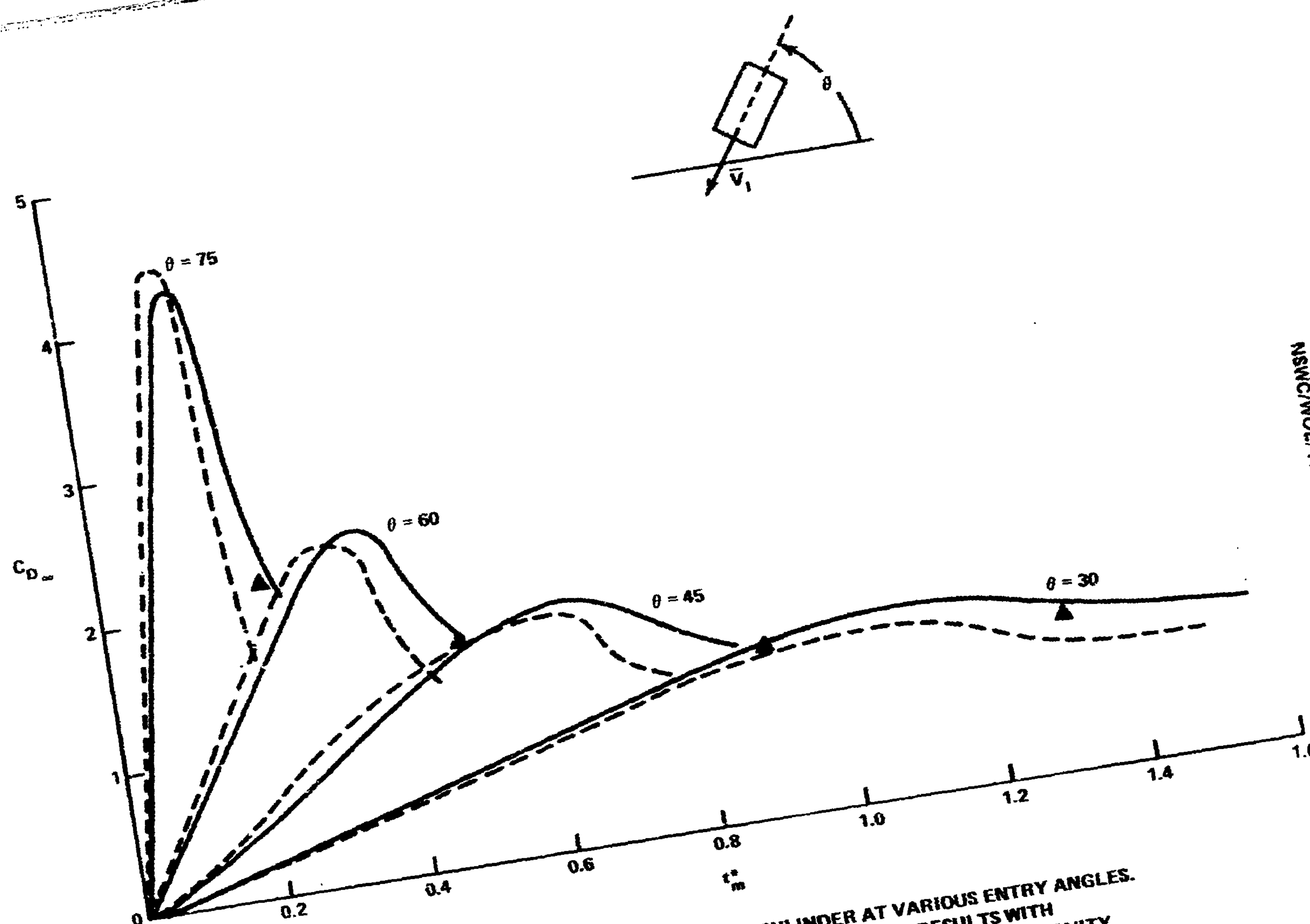

FIG. 12 PREDICTED AND MEASURED DRAG ON A DISK CYLINDER AT VARIOUS ENTRY ANGLES. ——— EXPERIMENTAL DATA BY BALDWIN[13] – – – CALCULATED RESULTS WITH C_W = 1.45 AND USING A GRID COVERING ONLY THE NOSE OF THE MODEL. ▲ CAVITY SHAPE MODELED WITH NO LOAD ELEMENTS.

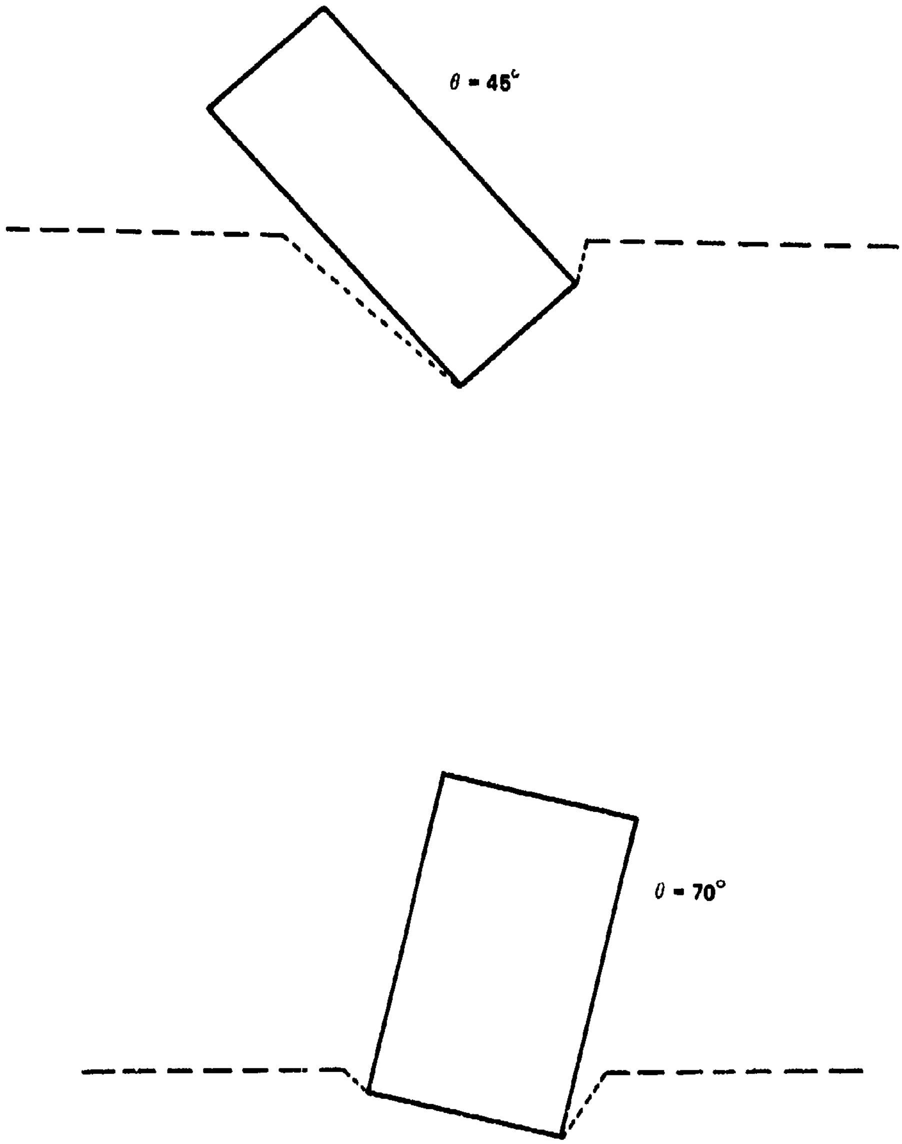

FIG. 13 PROFILE OF THE CAVITY ABOUT A DISK CYLINDER AT SEVERAL ENTRY ANGLES CALCULATED USING NO LOAD ELEMENTS. — — EFFECTIVE PLANAR SURFACE - - - WATER-CAVITY INTERFACE.

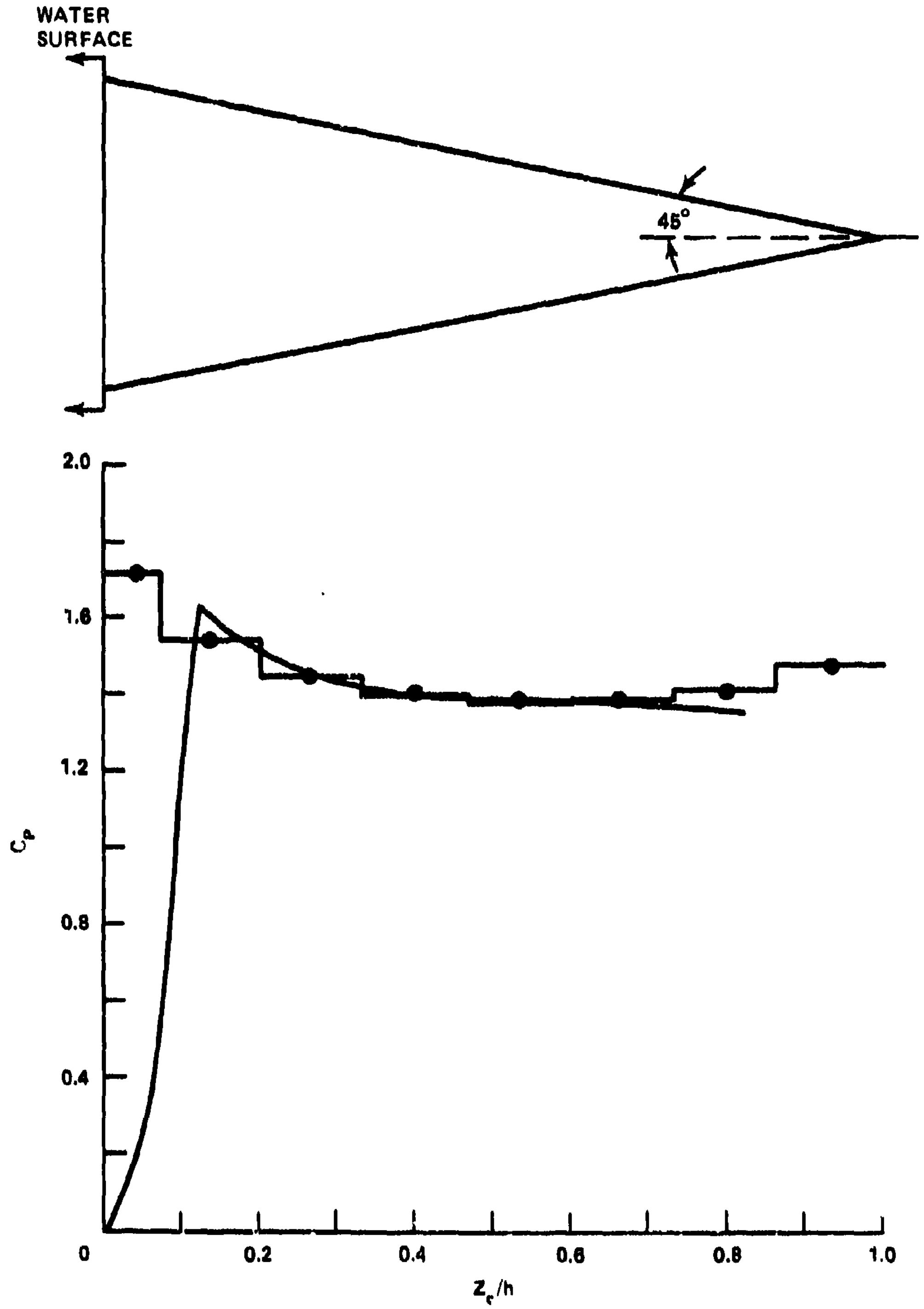

FIG. 14 PRESSURE DISTRIBUTION ON A 45 DEGREE HALF-ANGLE CONE ENTERING VERTICALLY. THE SHADED CIRCLES REPRESENT THE CALCULATED VALUES AT ELEMENT CENTRIODS WHILE THE HORIZONTAL LINES INDICATE THE EXTENT OF EACH ELEMENT. THE ELEMENT ADJACENT TO THE WATER SURFACE IS MODIFIED. C_w = 1.45. THE SOLID CURVE IS EXPERIMENTAL DATA BY BALDWIN[13].

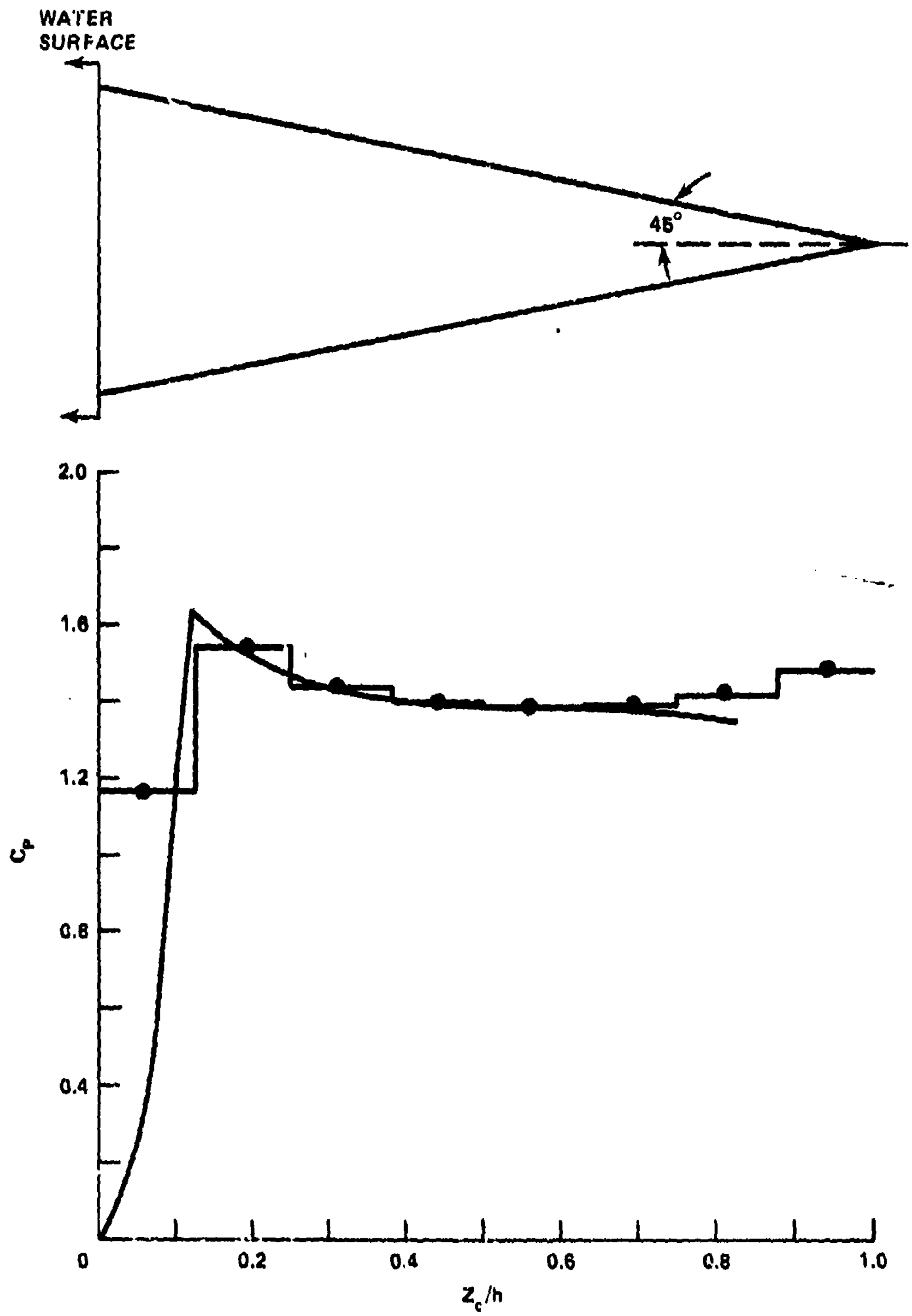

FIG. 15 PRESSURE DISTRIBUTION ON A 45 DEGREE HALF ANGLE CONE ENTERING VERTICALLY. THE SHADED CIRCLES REPRESENT THE CALCULATED VALUES AT ELEMENT CENTROIDS WHILE THE HORIZONTAL LINES INDICATE THE EXTEND OF EACH ELEMENT. THE SOLID CURVE IS EXPERIMENTAL DATA BY BALDWIN[13]. THE ELEMENT ADJACENT TO THE WATER SURFACE IS NOT MODIFIED. $C_w = 1.45$.

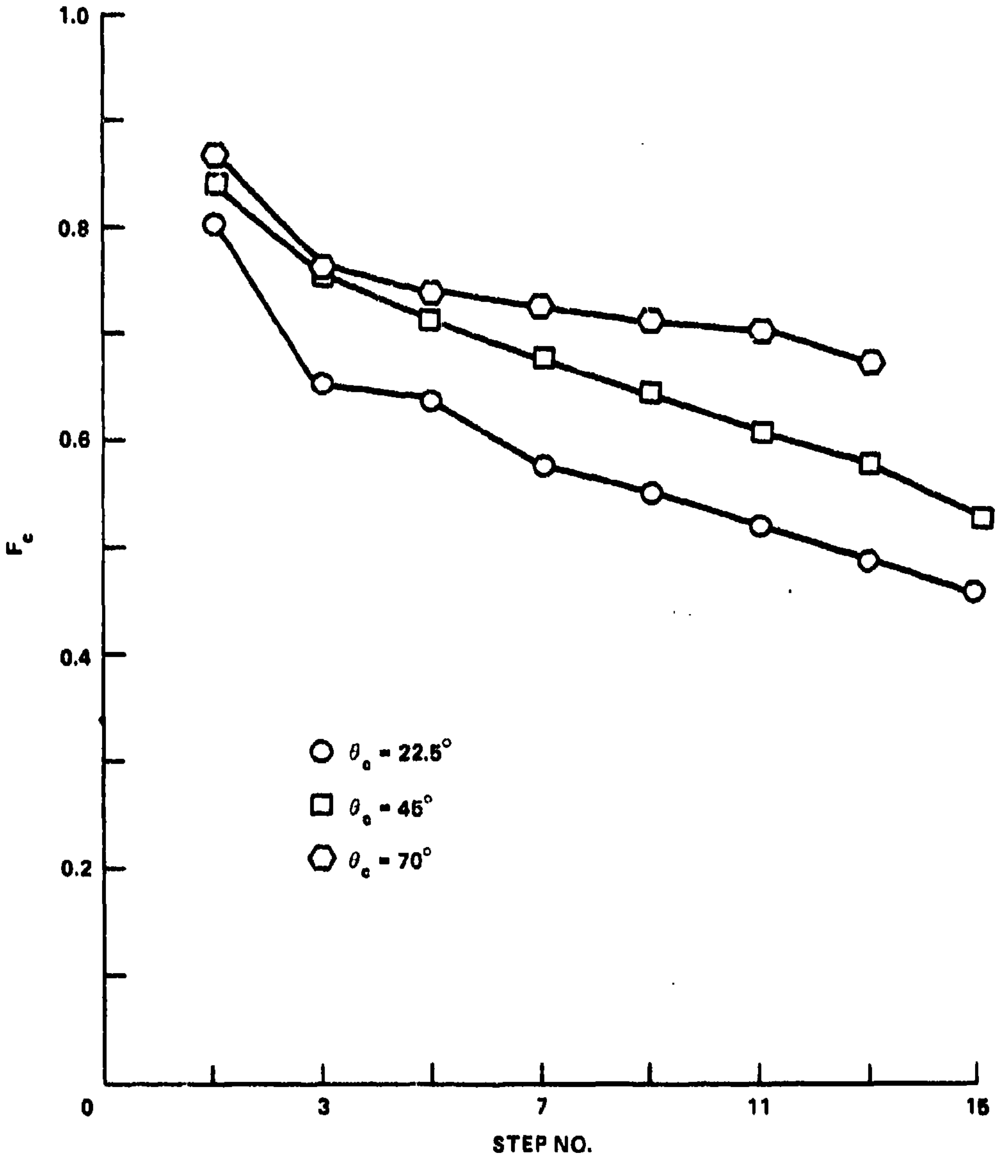

FIG. 16 MODIFIED ELEMENT CORRECTION FACTOR AS A FUNCTION OF STEP NUMBER.

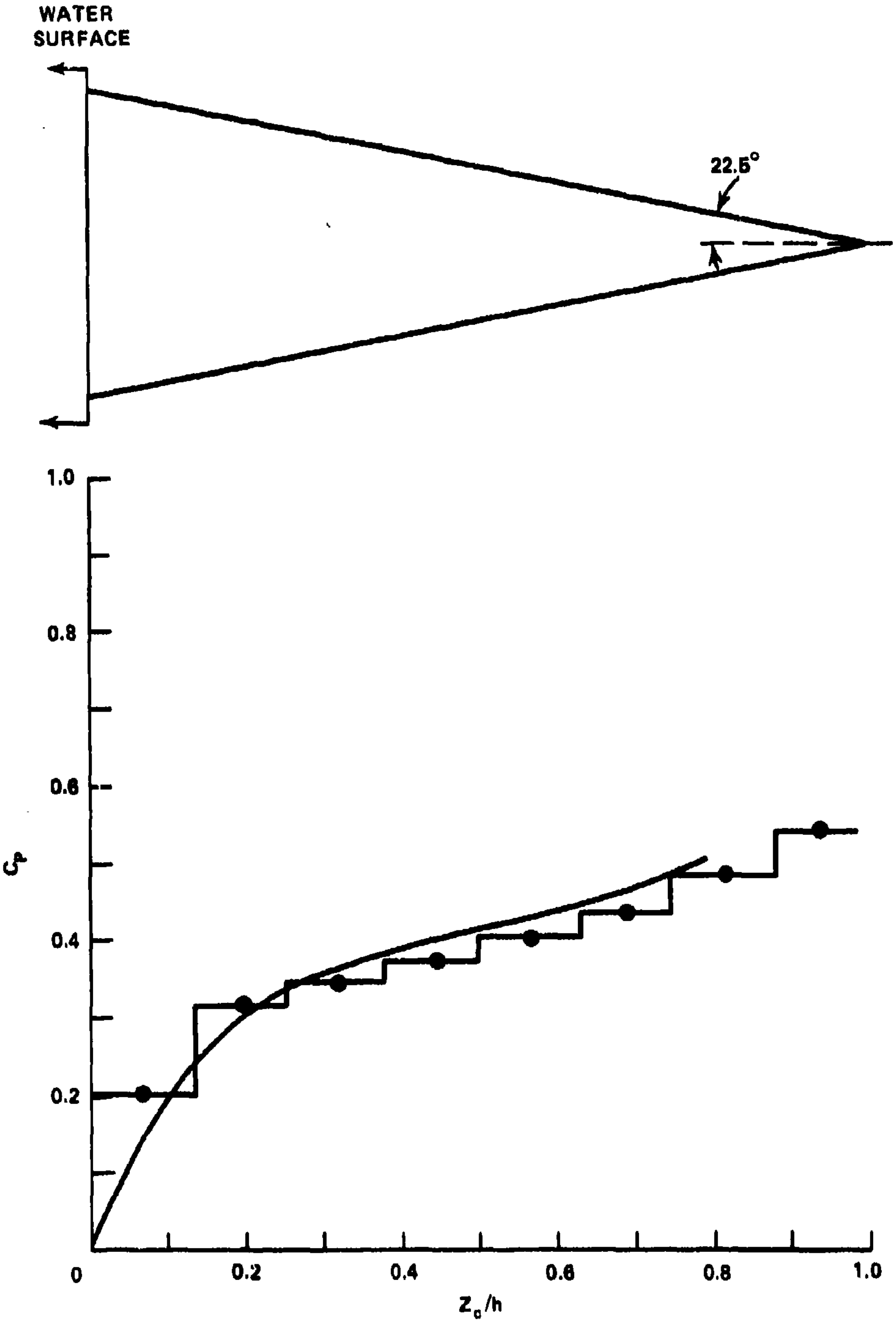

FIG. 17 PRESSURE DISTRIBUTION ON A 22.5 DEGREE HALF-ANGLE CONE ENTERING VERTICALLY THE SHADED CIRCLES REPRESENT THE CALCULATED VALUE AT EACH ELEMENT CENTROID. WHILE THE HORIZONTAL LINES INDICATE THE EXTENT OF EACH ELEMENT. THE SOLID CURVE IS EXPERIMENTAL DATA BY BALDWIN[13], $C_w = 1.14$.

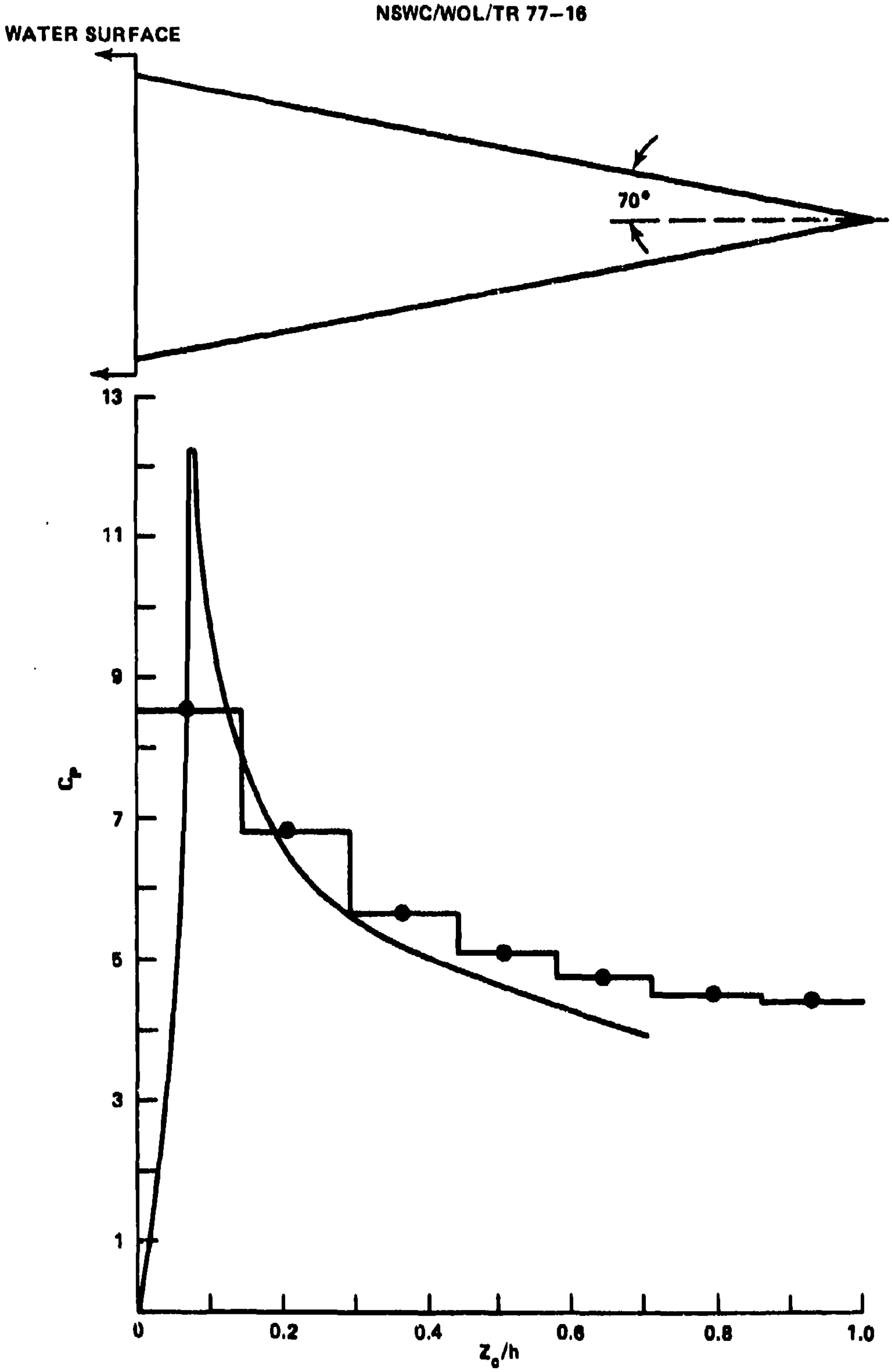

FIG. 18 PRESSURE DISTRIBUTION ON A 70 DEGREE HALF-ANGLE CONE ENTERING VERTICALLY. THE SHADED CIRCLES REPRESENT THE CALCULATED VALUE AT EACH ELEMENT CENTROID WHILE THE HORIZONTAL LINES INDICATE THE EXTENT OF EACH ELEMENT. THE SOLID CURVE IS EXPERIMENTAL DATA BY BALDWIN[13], $C_w = 1.39$.

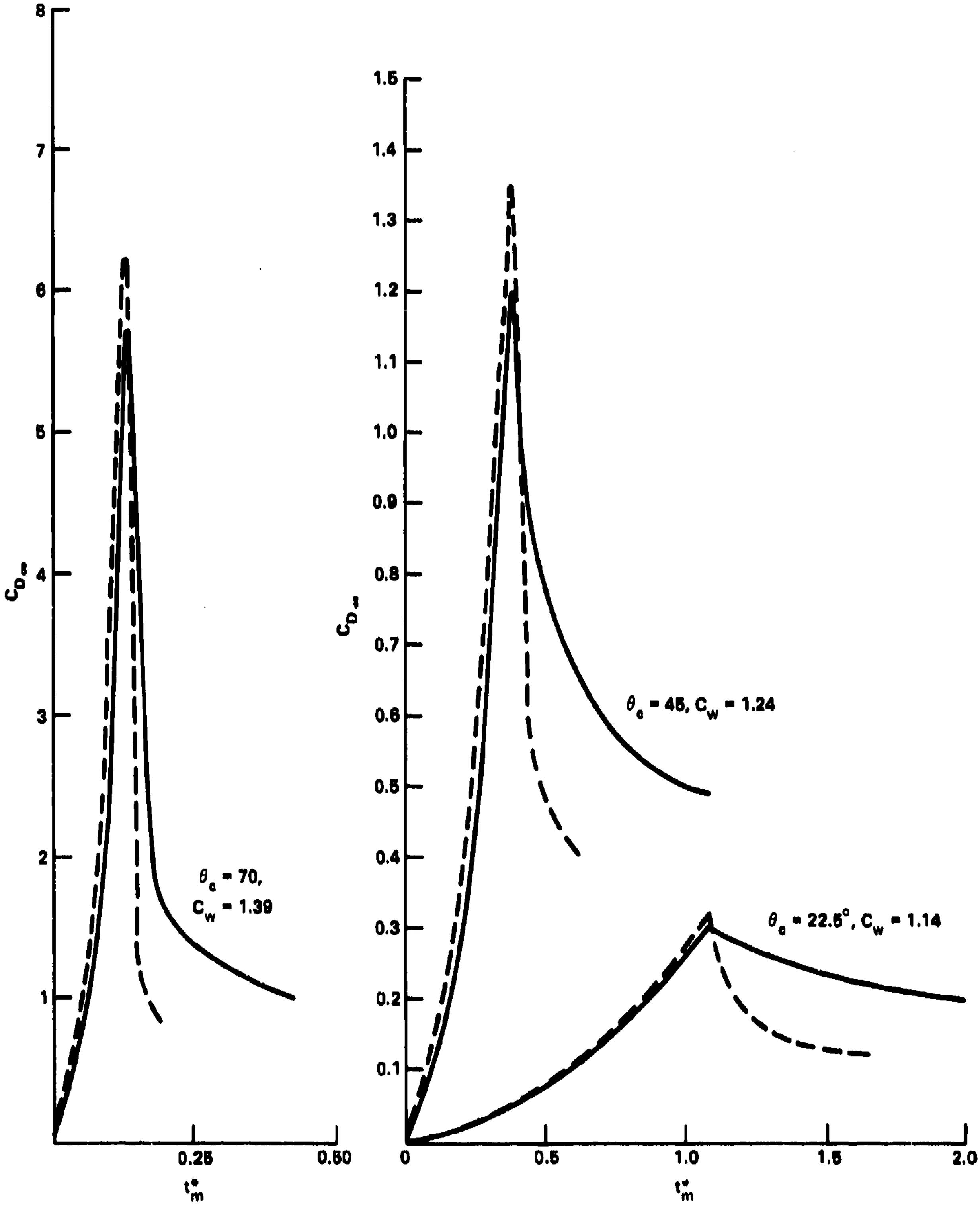

FIG. 19 CALCULATED AND MEASURED DRAG ON VERTICALLY ENTERING CONES.
——— MEASURED BY BALDWIN[14] — — — CALCULATED.

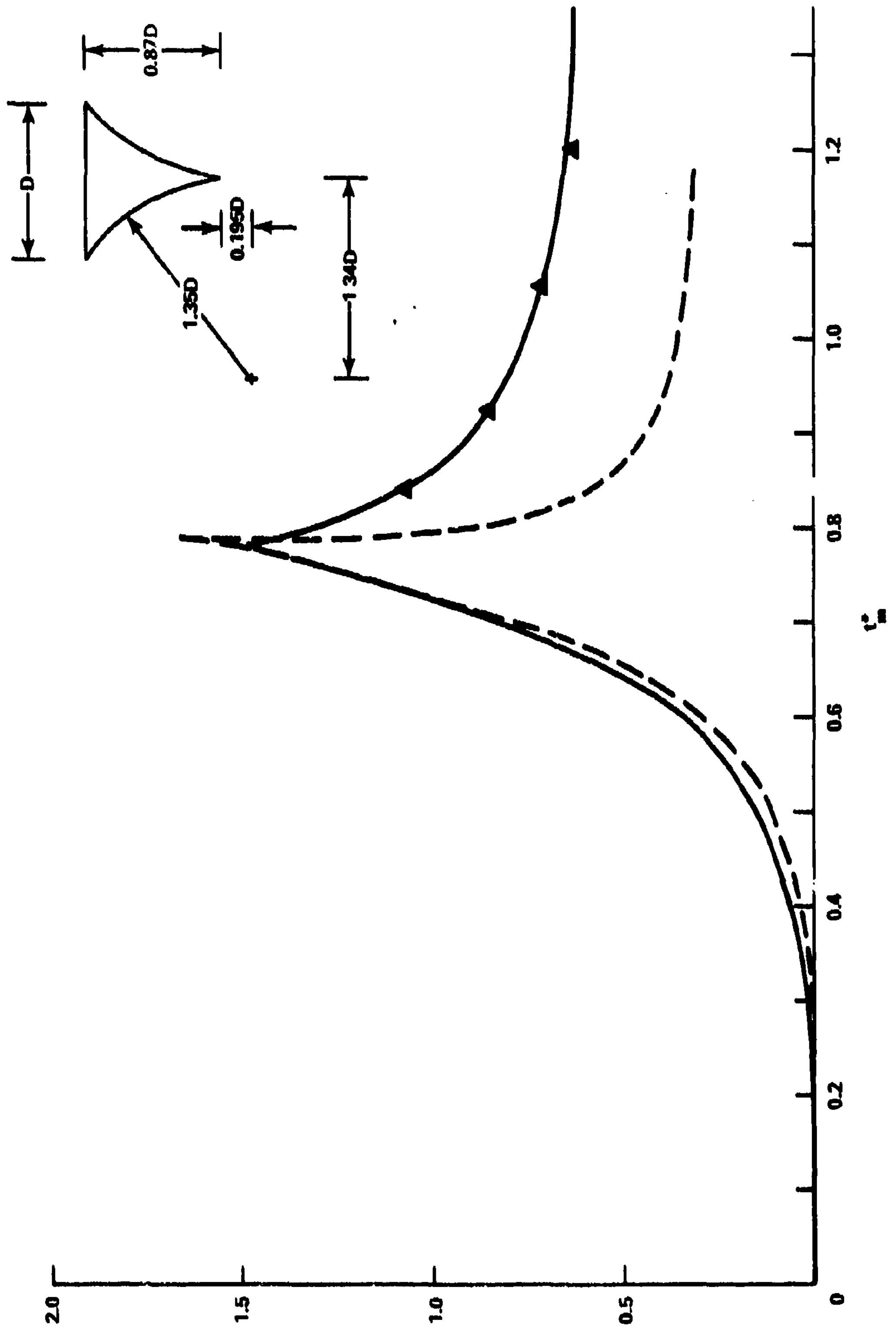

FIG. 20 CALCULATED AND MEASURED DRAG ON A VERTICALLY ENTERING CUSP. – – CALCULATED. ——— MEASURED[16] ▲ CALCULATED WITH A CAVITY SIMULATED BY NO LOAD ELEMENTS.

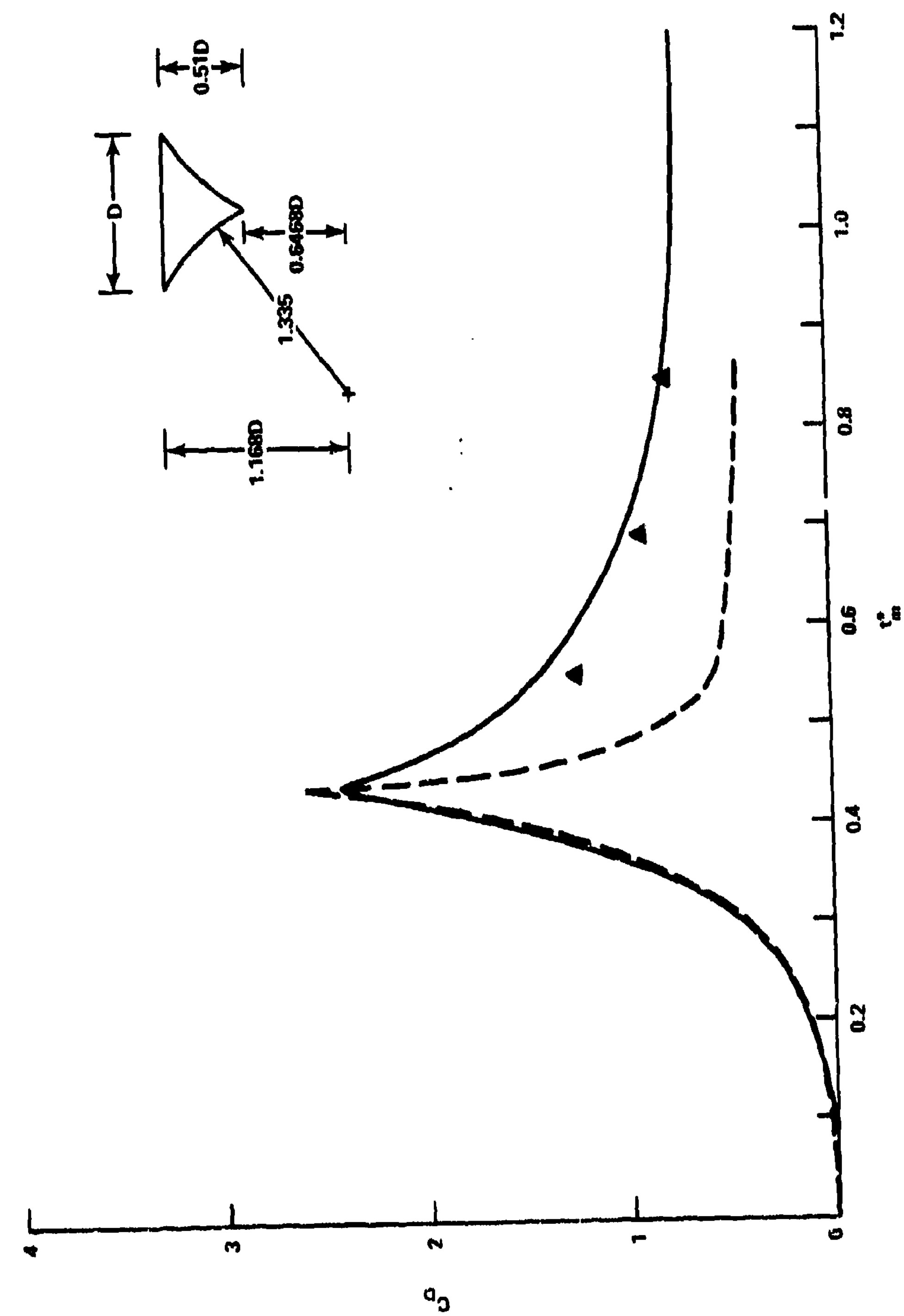

FIG. 21 CALCULATED AND MEASURED DRAG ON A VERTICALLY ENTERING CUSP. – – CALCULATED —— MEASURED[16] ▲CALCULATED WITH A CAVITY SIMULATED BY NO LOAD ELEMENTS.

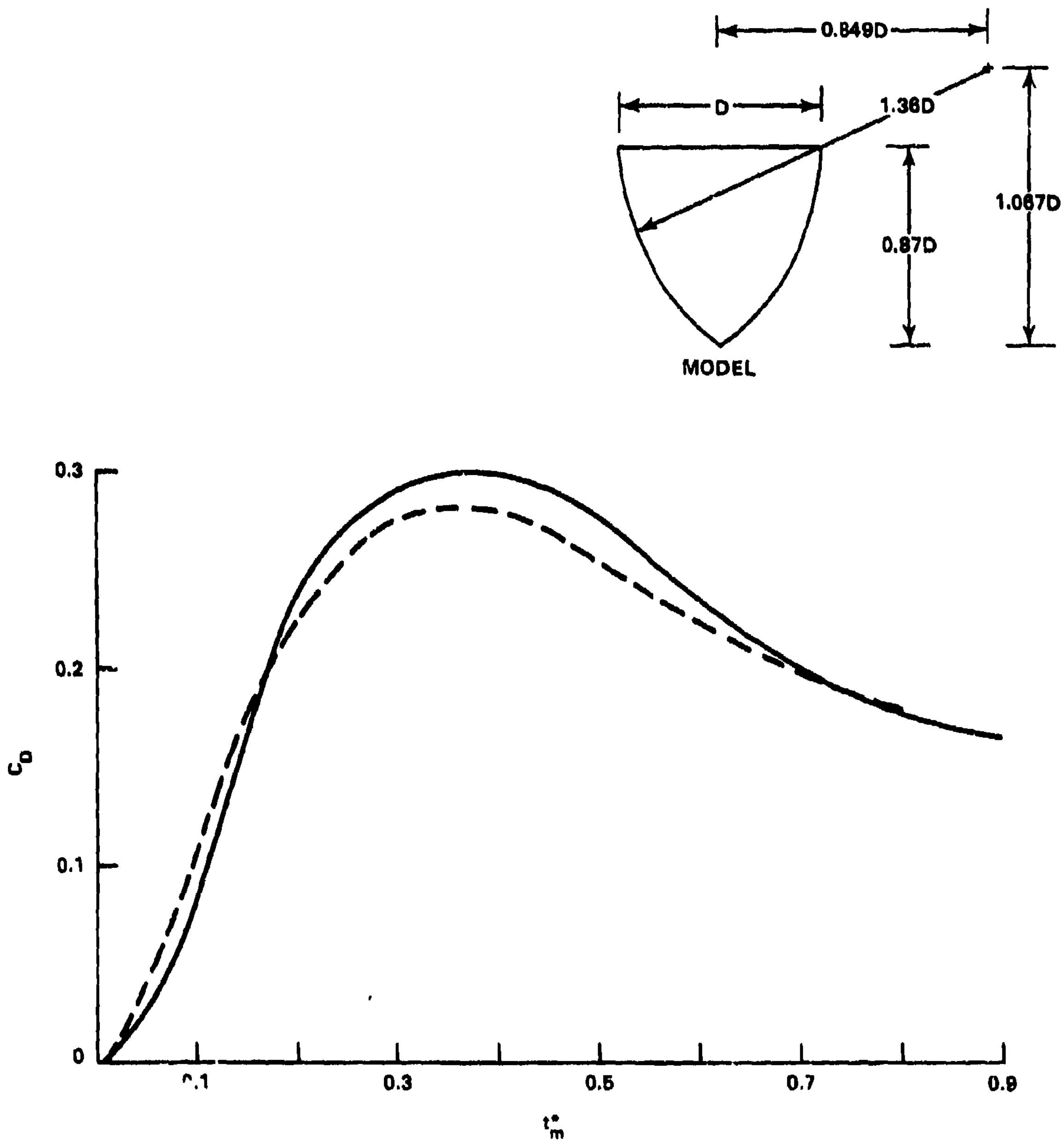

FIG. 22 CALCULATED AND MEASURED DRAG ON A VERTICALLY ENTERING OGIVE.
– – CALCULATED —— MEASURED[16].

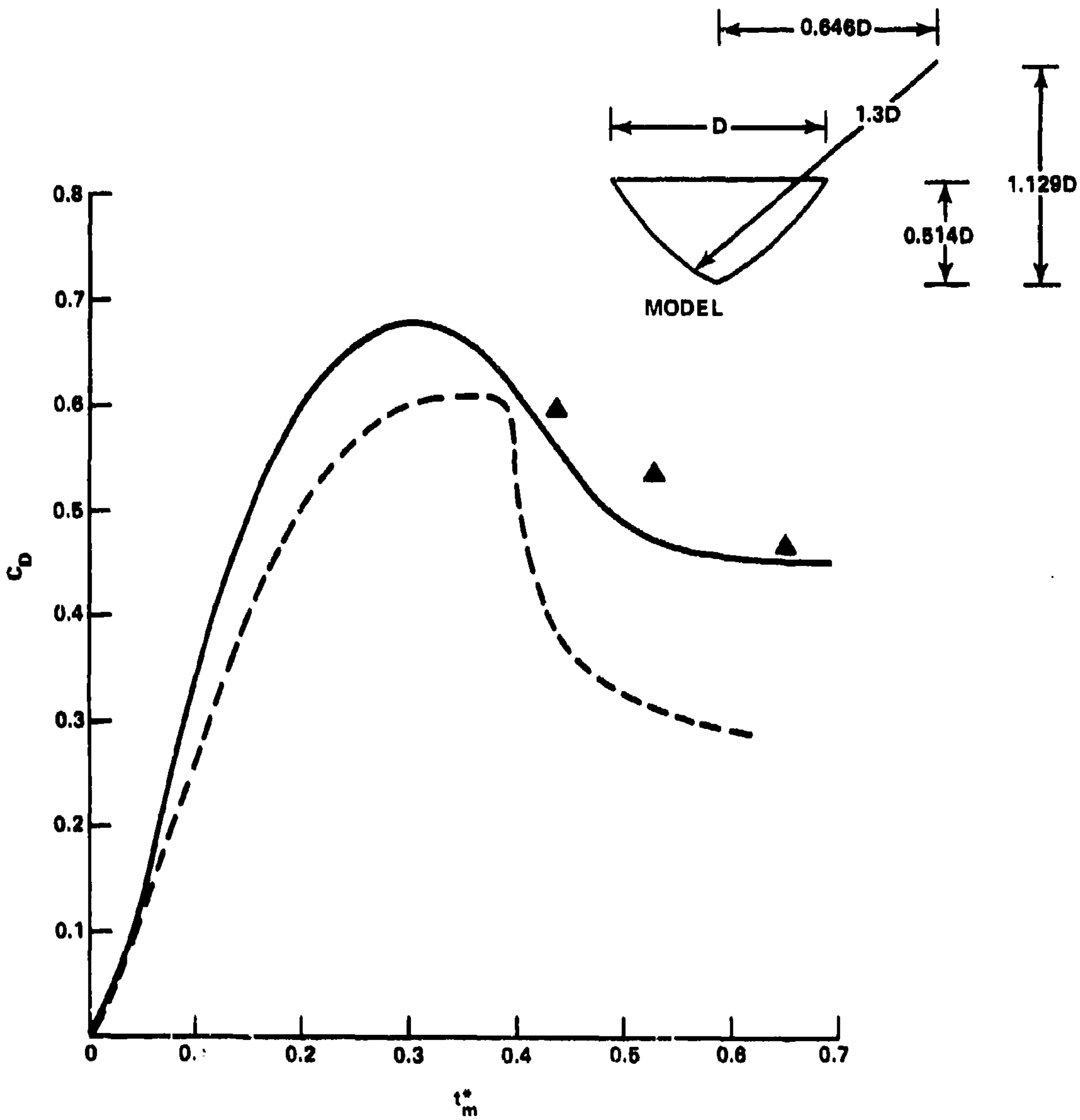

FIG. 23 CALCULATED AND MEASURED DRAG ON A VERTICALLY ENTERING OGIVE. — — CALCULATED ——— MEASURED[16]. ▲CALCULATED WITH A CAVITY SIMULATED BY NO LOAD ELEMENTS.

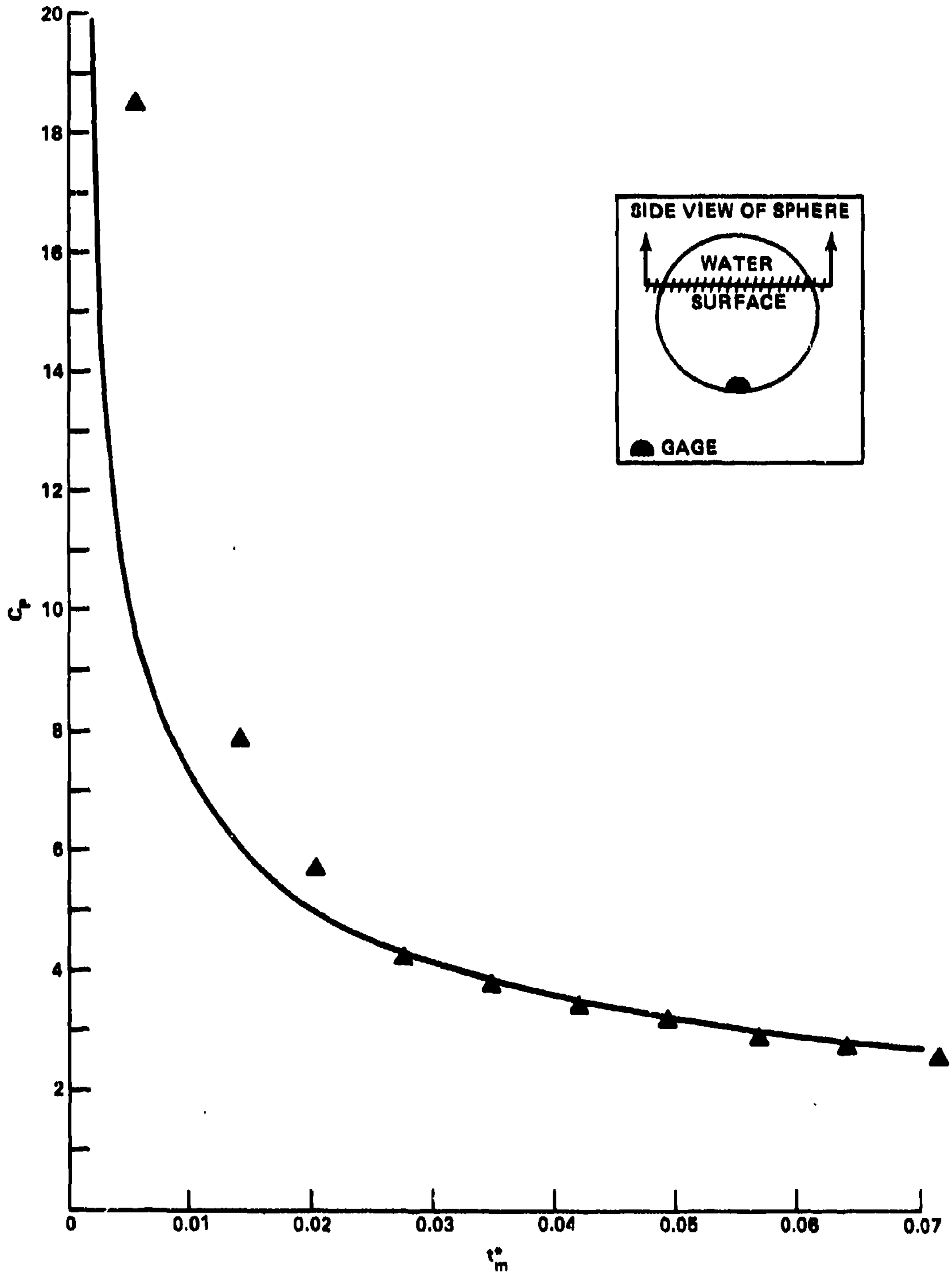

FIG. 24 CALCULATED AND MEASURED STAGNATION PRESSURE ON A SPHERE ENTERING VERTICALLY AT 23.5 FT/SEC. —— MEASURED BY NISEWANGER[17] ▲COMPUTED USING A C_W VALUE DEFINED BY EQUATION (26).

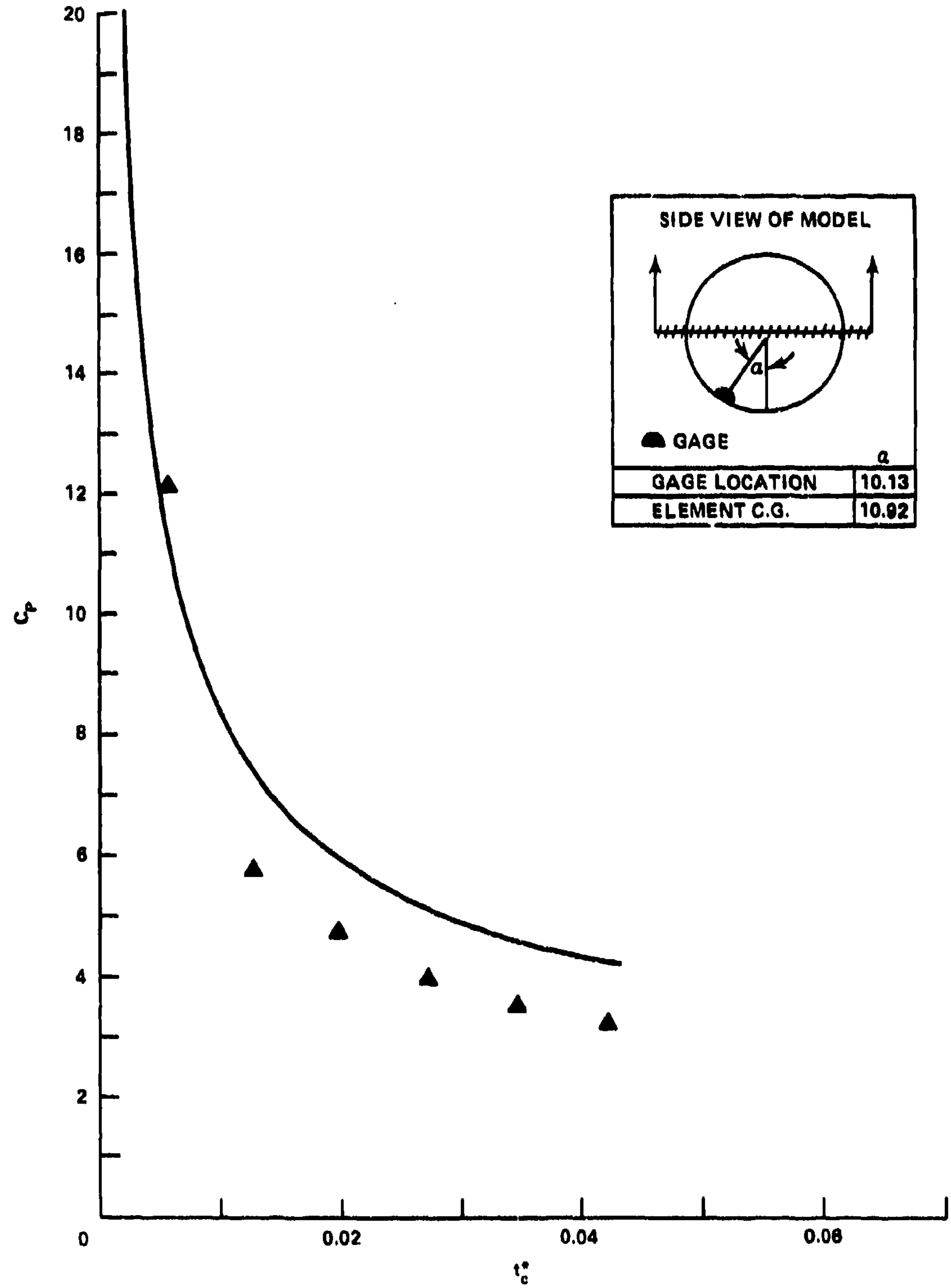

FIG. 25 CALCULATED AND MEASURED PRESSURE COEFFICIENT ON A VERTICALLY ENTERING SPHERE. —— MEASURED BY NISEWANGER[17] ▲ CALCULATED USING THE C_W FACTOR DEFINED BY EQUATION (26).

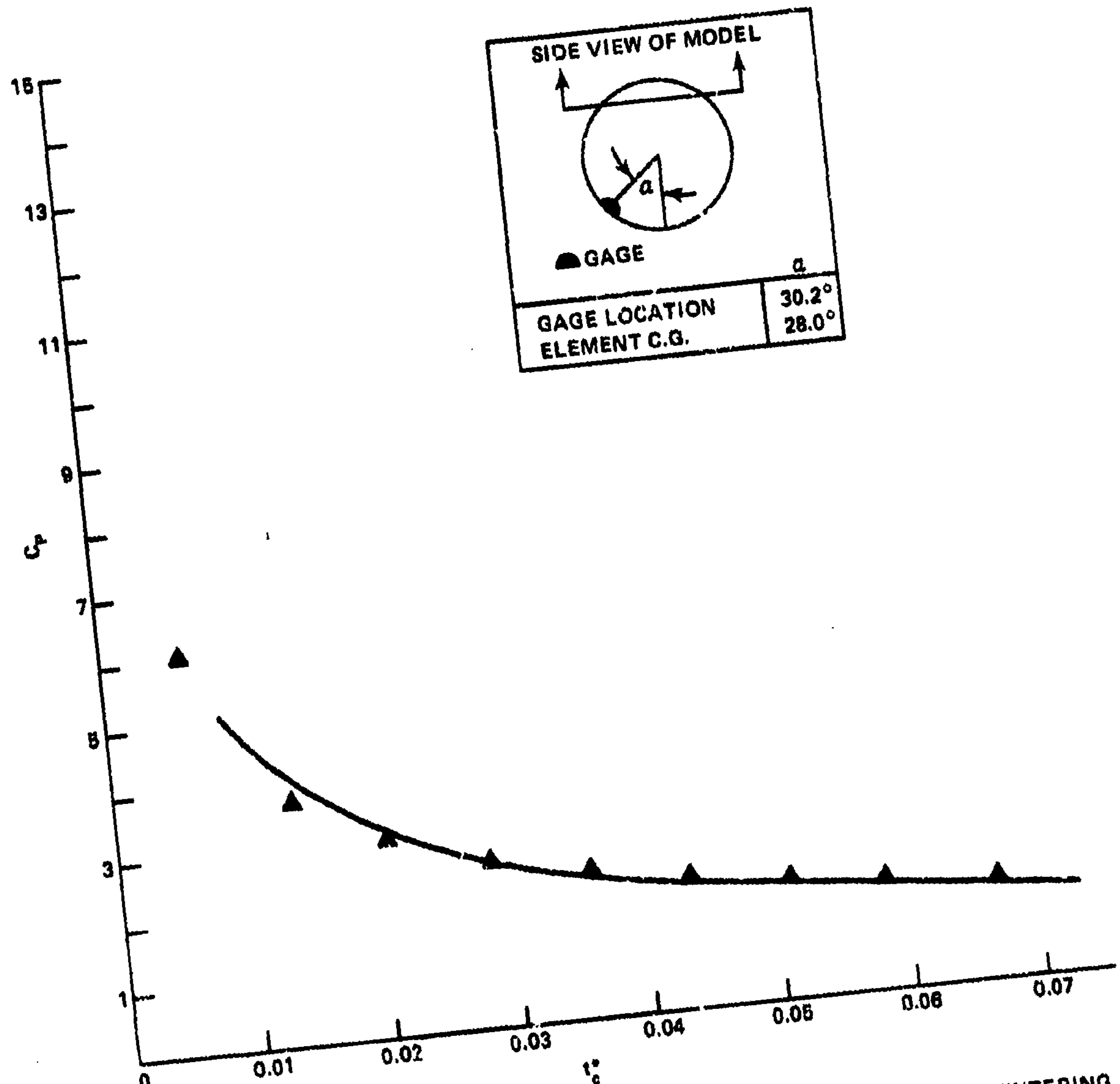

FIG. 26 CALCULATED AND MEASURED PRESSURE COEFFICIENT ON A VERTICALLY ENTERING SPHERE. ——— MEASURED BY NISEWANGER [17] ▲ CALCULATED USING THE C_W FACTOR DEFINED IN EQUATION (25).

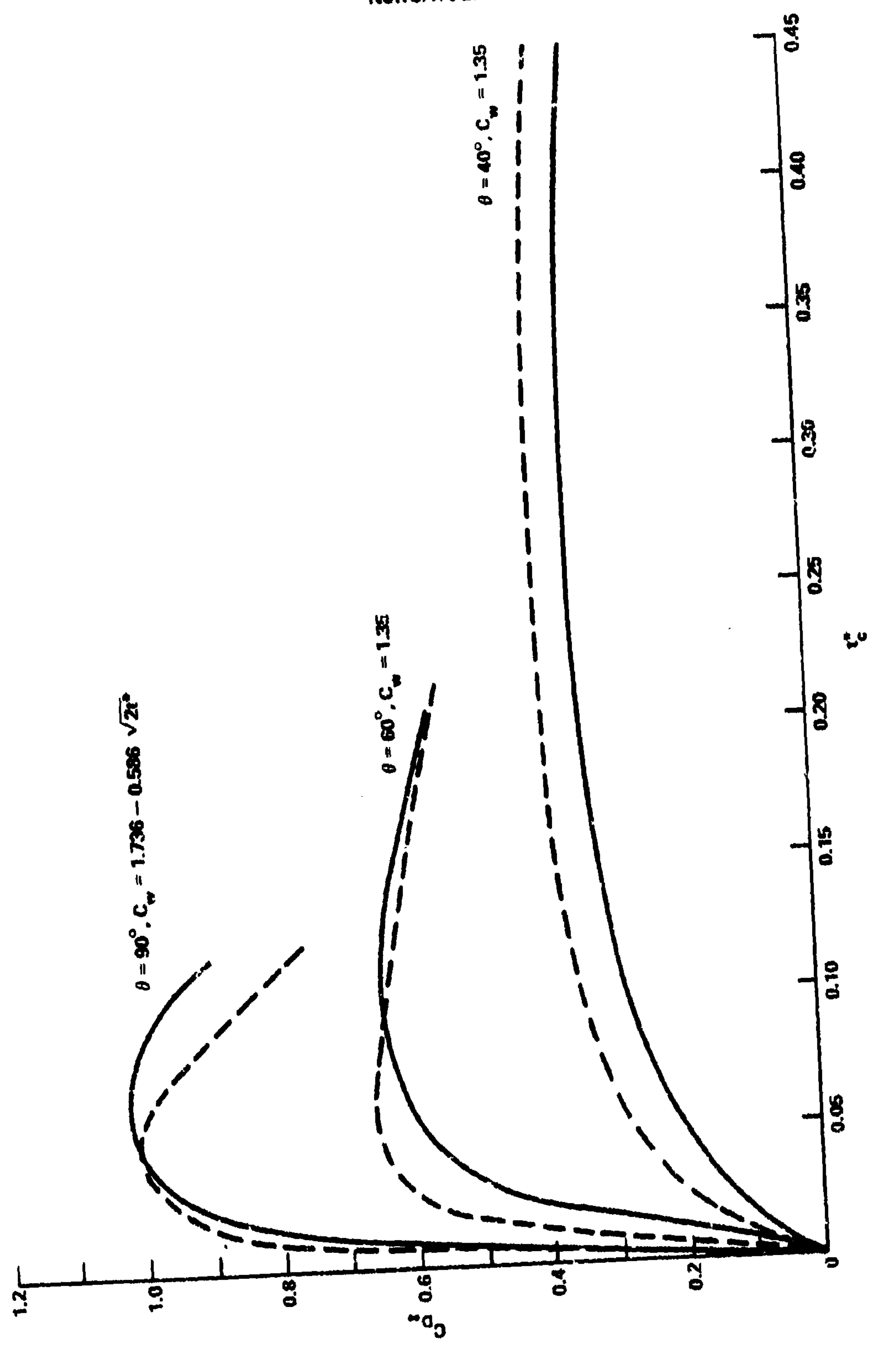

FIG. 27 CALCULATED AND MEASURED DRAG ON A SPHERE AT VARIOUS ENTRY ANGLES. ——— MEASURED 2.17 – – – CALCULATED.

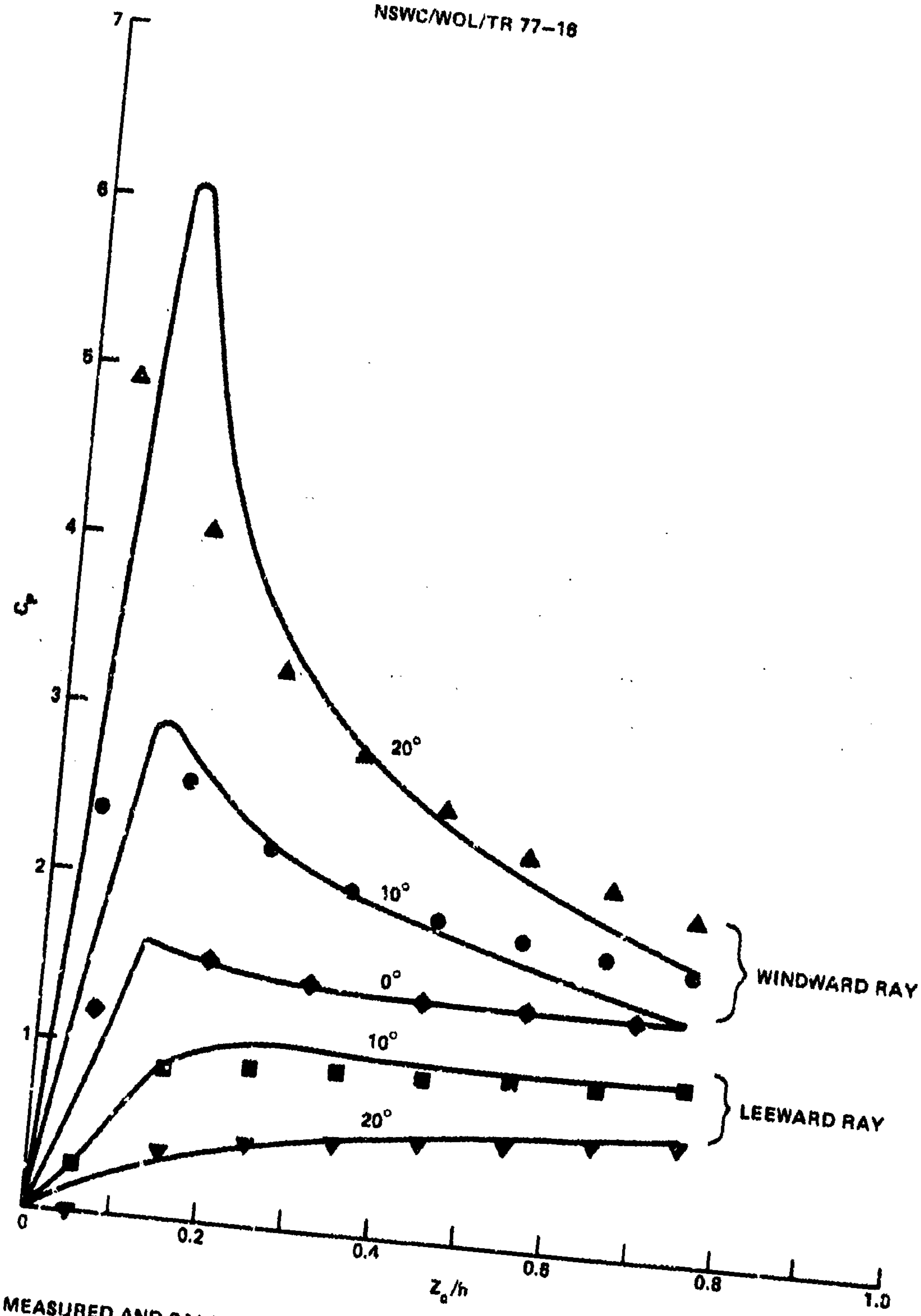

FIG. 28 MEASURED AND CALCULATED PRESSURE DISTRIBUTION ON A VERTICALLY ENTERING 45 DEGREE HALF-ANGLE CONE AT 0, 10, 20 DEGREE INCIDENCE. —— UNPUBLISHED EXPERIMENTAL DATA BY BALDWIN. SOLID SYMBOLS ARE CALCULATIONS.

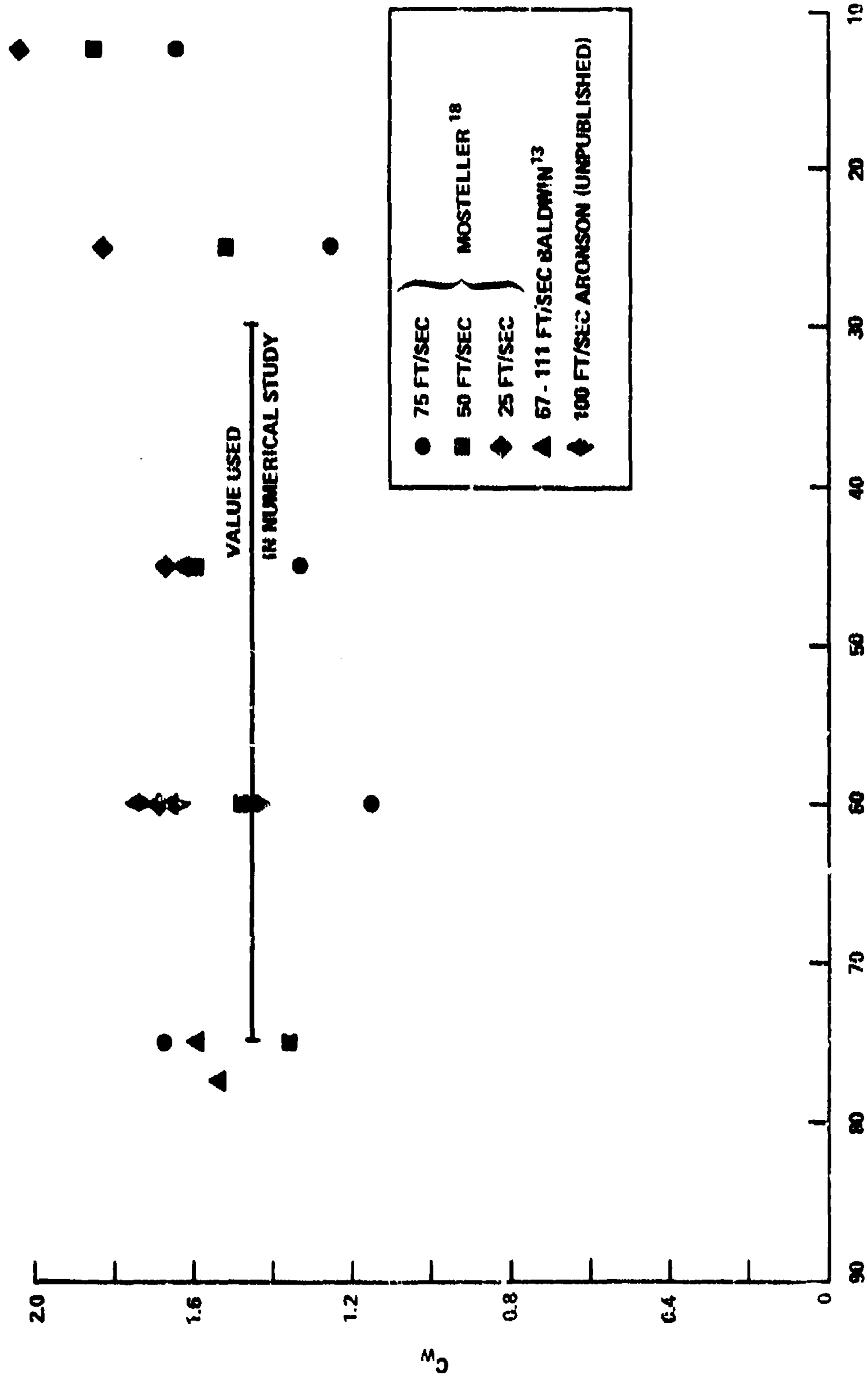

FIG. 29 EXPERIMENTALLY DETERMINED VALUES OF C_W FOR THE OBLIQUE ENTRY OF A DISK CYLINDER

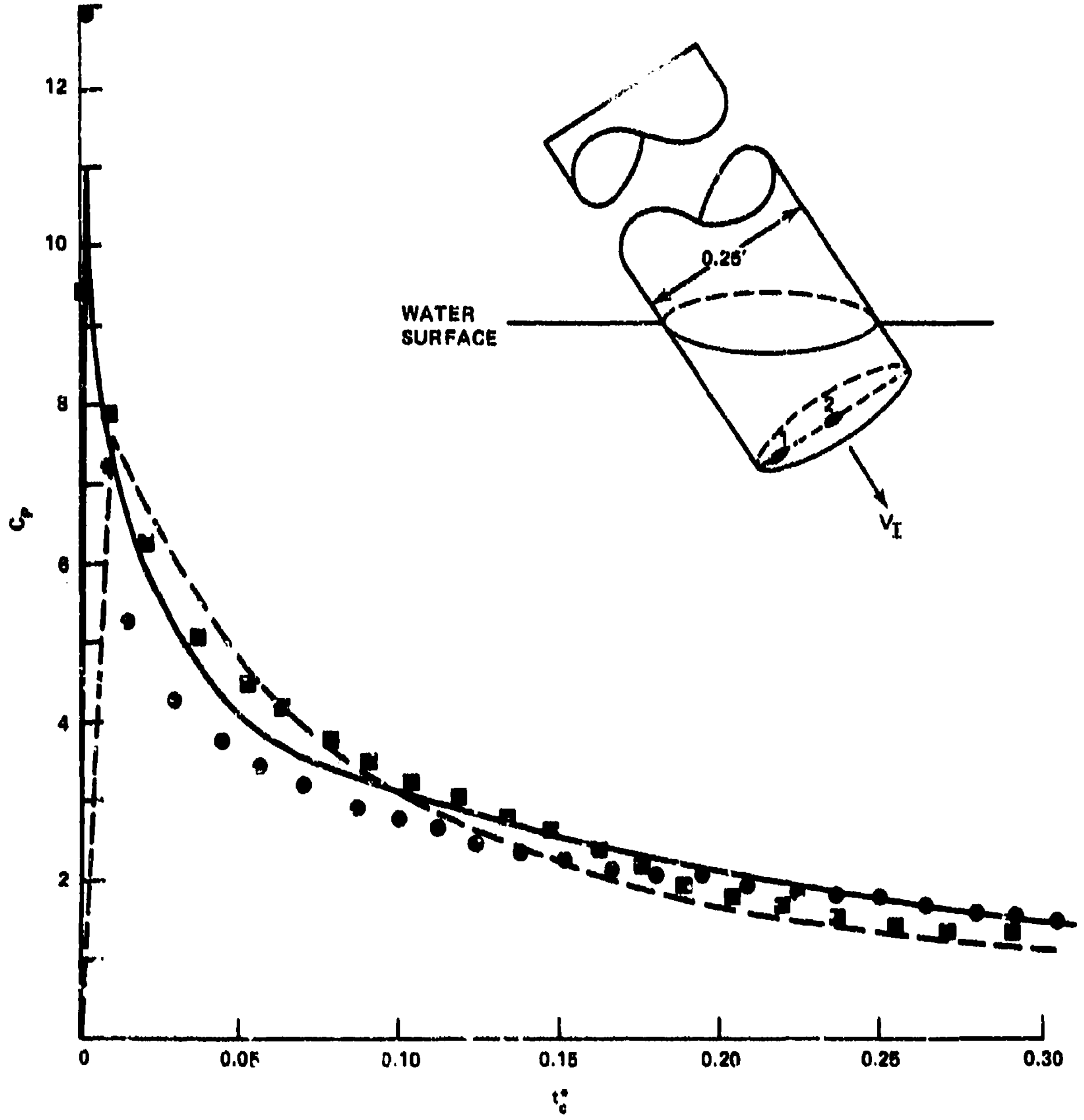

FIG. 30 CALCULATED AND MEASURED PRESSURE-TIME HISTORIES AT TWO DIFFERENT POSITIONS ON THE SURFACE OF A DISK CYLINDER, θ = 60 AND V_I = 100 FT/SEC. —— MEASURED AT POSITION 1 (r = 0.098 β = 4°) ● CALCULATED AT POSITION 1. – – – MEASURED AT POSITION 2 (r = 0) ■ CALCULATED AT POSITION 2. MEASUREMENTS BY ARONSON.

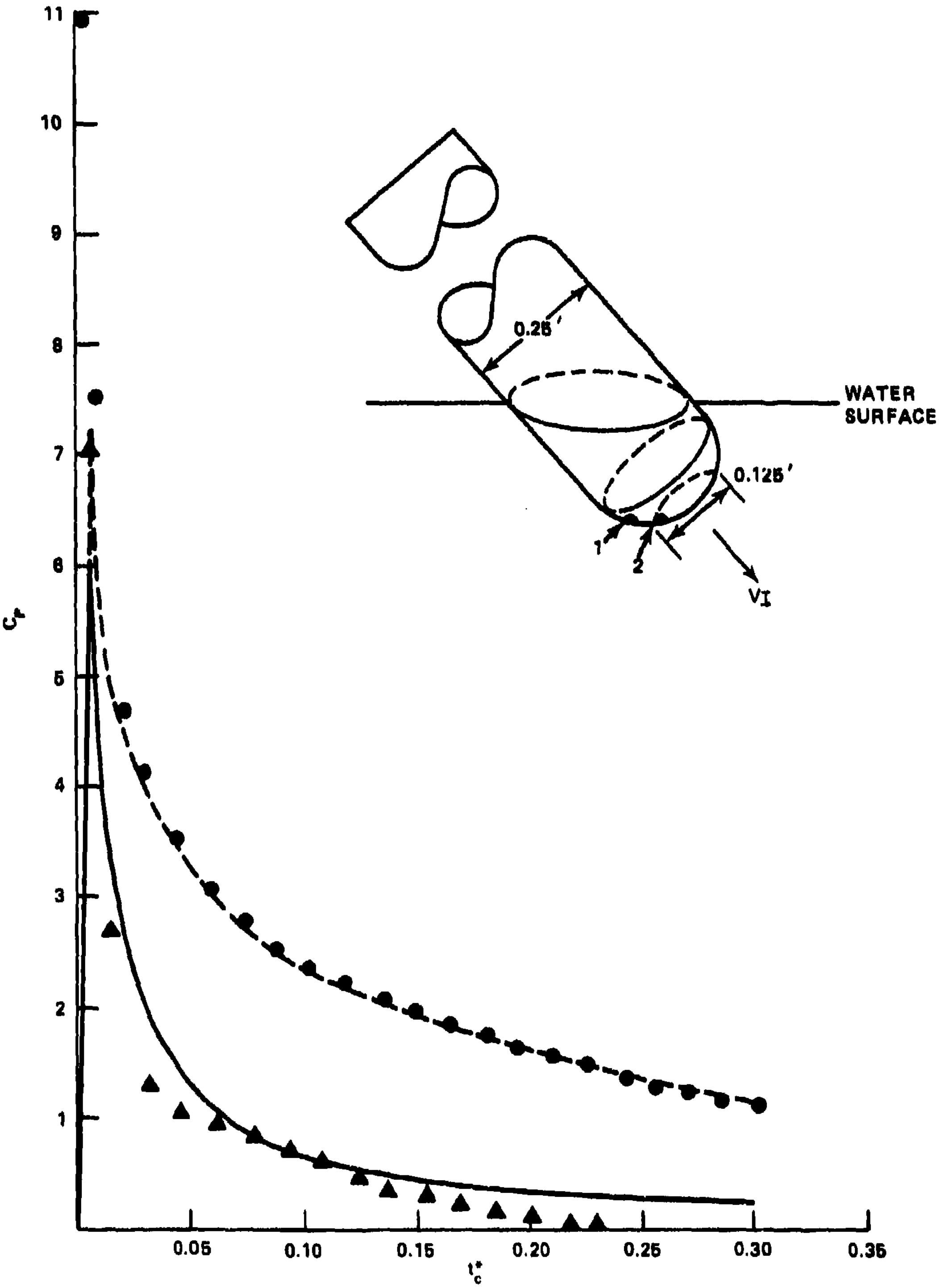

FIG. 31 CALCULATED AND MEASURED PRESSURE-TIME HISTORIES AT TWO DIFFERENT POSITIONS ON THE SURFACE AT AN OGIVE CYLINDER, θ = 60 DEGREES AND V_I = 100 FT/SEC. ——— MEASURED AT POSITION 1 (r = 0.112', β = 9.5°) ▲CALCULATED AT POSITION 1. – – –MEASURED AT POSITION 2 (r = 0.063', β = 5.5°) ●CALCULATED AT POSITION 2. MEASUREMENTS ARE BY ARONSON

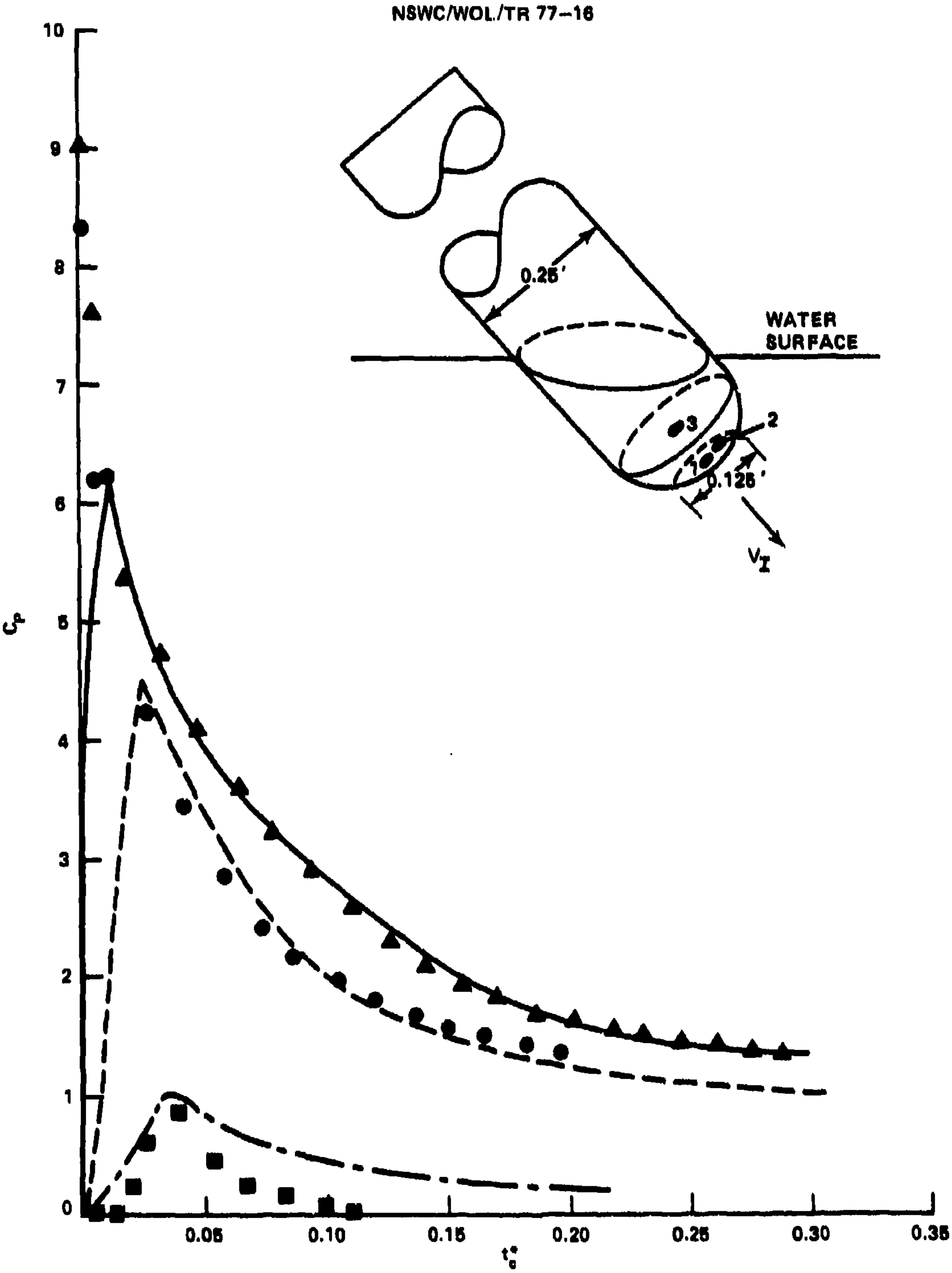

FIG. 32 CALCULATED AND MEASURED PRESSURE-TIME HISTORIES AT THREE DIFFERENT POSITIONS ON THE SURFACE OF AN OGIVE CYLINDER, Θ60 AND V_I = 100 FT/SEC. ▬ MEASURED AT POSITION 1 (r = 0) ▲ CALCULATED AT POSITION 1. ‒‒‒ MEASURED AT POSITION 2 (r = 0.048', β = 90°) ● CALCULATED AT POSITION 2. ‒ · ‒ MEASURED AT POSITION 3 (r = 0.112', β = 90°) ■ CALCULATED AT POSITION 3. DATA ARE BY ARONSON

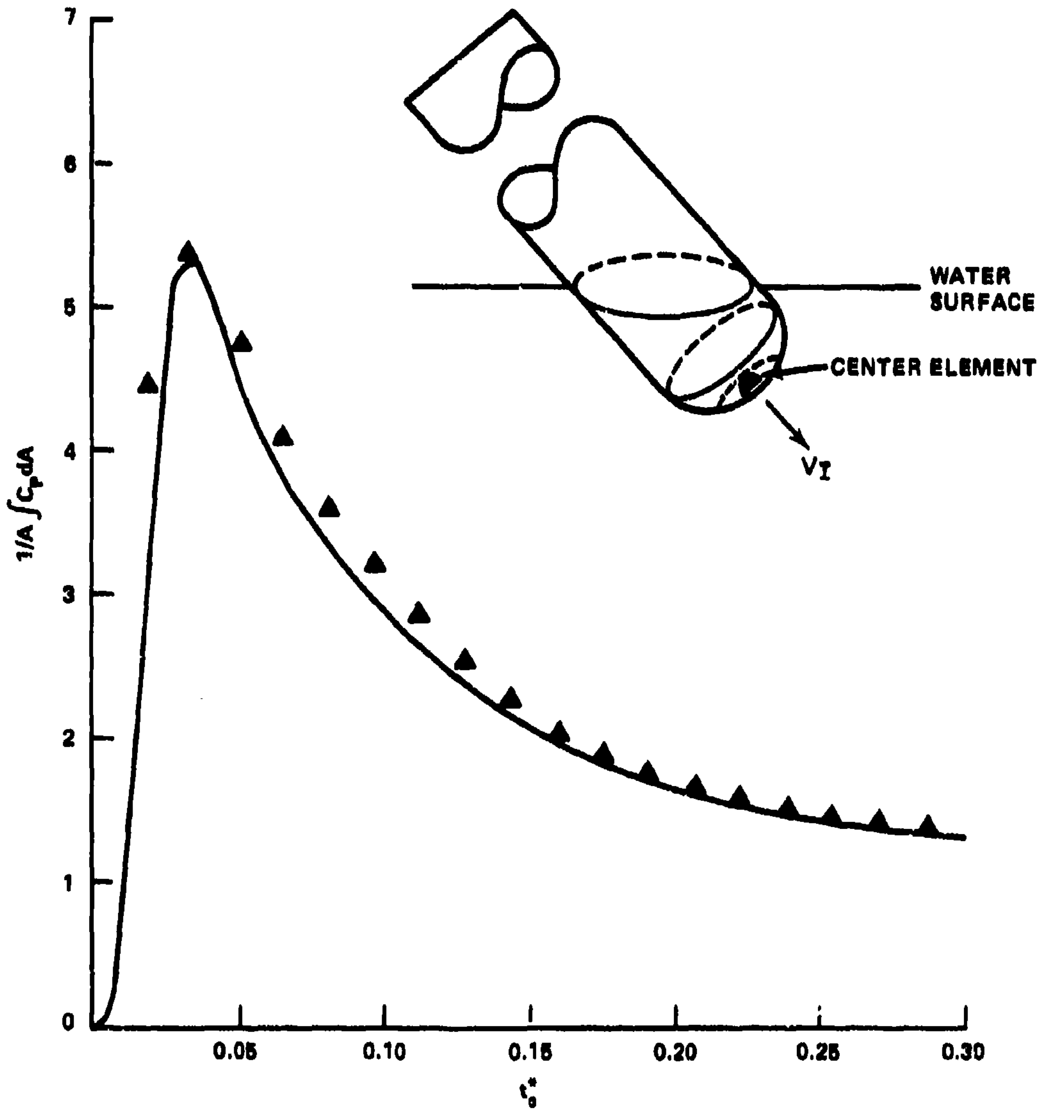

FIG. 33 CALCULATED AND EXPERIMENTAL LOAD ON THE CENTER ELEMENT OF THE OGIVE CYLINDER MODEL. ▲ CALCULATED. —— EXPERIMENTAL.

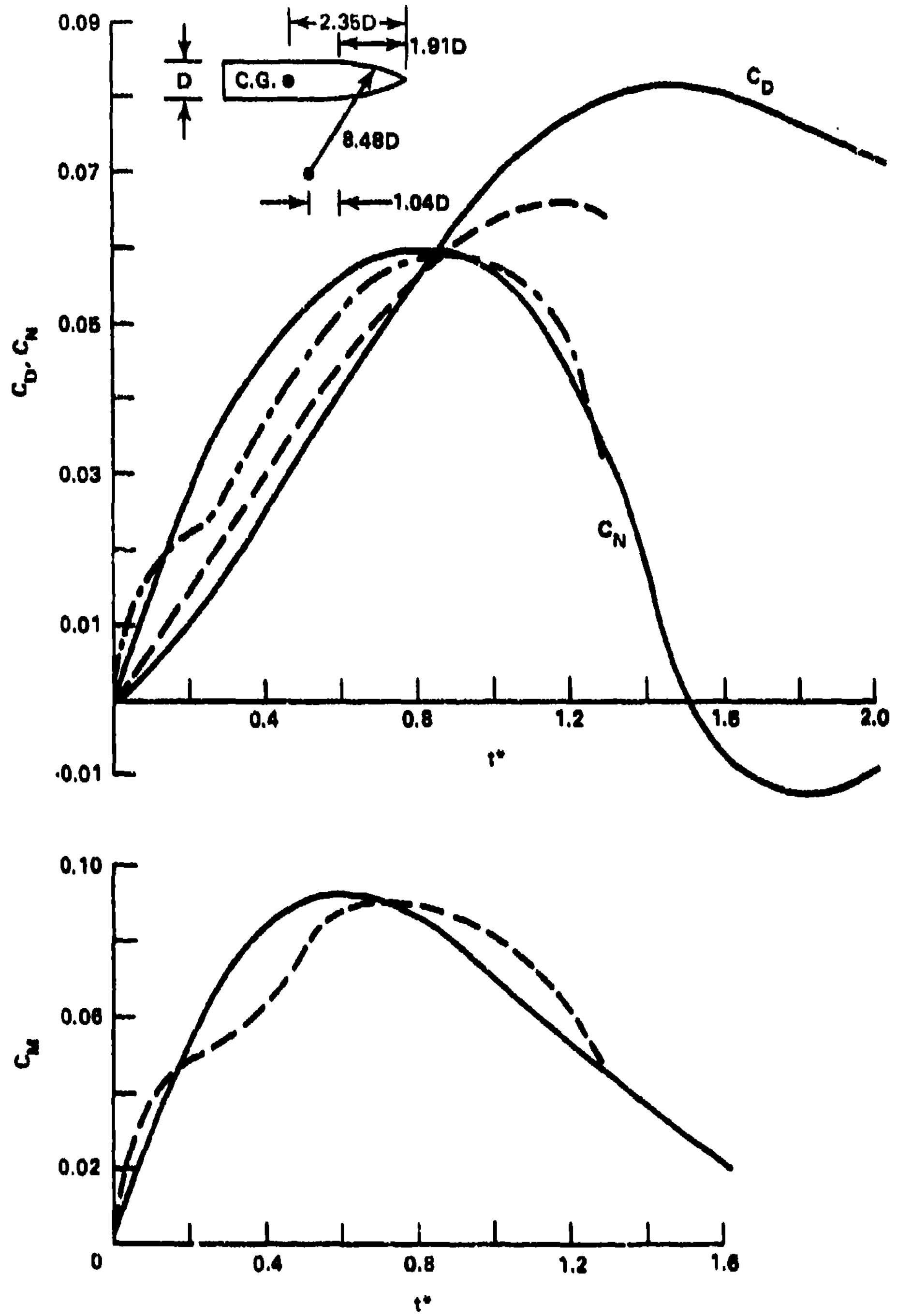

FIG. 34 MEASURED AND CALCULATED DRAG, PITCHING MOMENT AND NORMAL FORCE ON A SLENDER OGIVE ENTERING AT θ = 45° AND V_I=100 FT/SEC. SOLID CURVES ARE DATA BY BALDWIN. DOTTED AND DASHED CURVES ARE CALCULATED RESULTS.

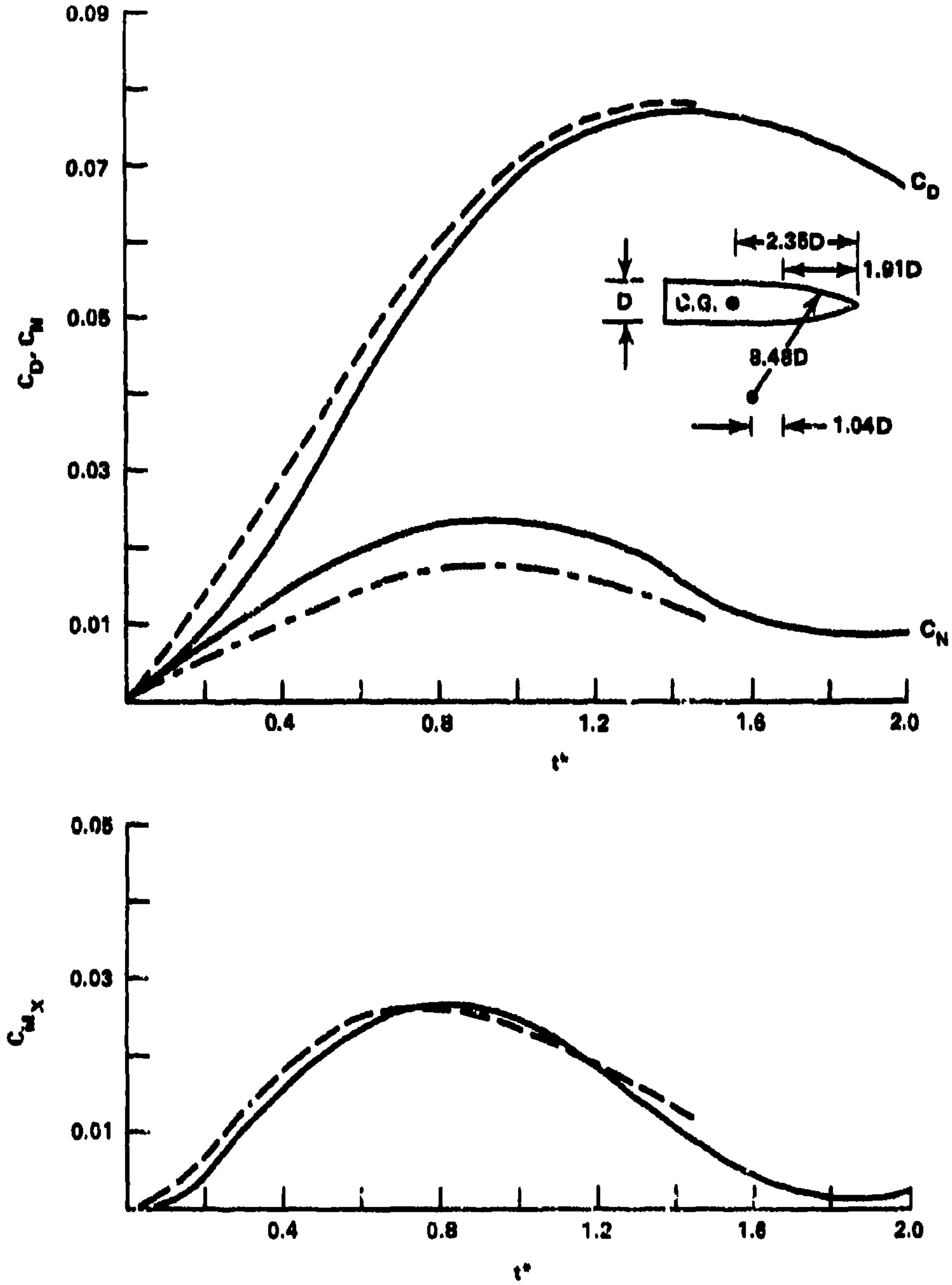

FIG. 35 MEASURED AND CALCULATED DRAG, PITCHING MOMENT AND NORMAL FORCE ON A SLENDER OGIVE ENTERING AT θ = 75° AND V ~ 100 FT/SEC. SOLID CURVES ARE DATA BY BALDWIN. DOTTED AND DASHED CURVES ARE CALCULATED RESULTS.

APPENDIX A

FORMULAS FOR THE INFLUENCE OF PLANAR, QUADRILATERAL ELEMENTS

This section lists formulas for calculating the influence of planar elements on arbitrary points in space, x,y,z. These expressions are taken from reference (11) and are listed here for the sake of completeness. The symbols to be used are defined in Figure A-1. Calculations are carried out using the element coordinate system and hence the velocity components are referenced to these axis:

$$V_\xi = -S_{12}Q_{12} - S_{23}Q_{23} - S_{34}Q_{34} - S_{41}Q_{41}$$

$$V_\eta = C_{12}Q_{12} + C_{23}Q_{23} + C_{34}Q_{34} + C_{41}Q_{41}$$

$$V_\gamma = \text{sign}(z)[\Delta\theta - J_{12} - J_{23} - J_{34} - J_{41}]$$

$$\phi = \phi_{12} + \phi_{23} + \phi_{34} + \phi_{41} - |z|\Delta\theta$$

where:

$\Delta\phi = 0$ unless $R_{12}, R_{23}, R_{34}, R_{41} > 0$ Then $\Delta\phi$ is 2π

$$\phi_{ij} = R_{ij}Q_{ij} + |z|J_{ij}$$

$$R_{ij} = (x - \xi_i)S_{ij} - (y - \eta_i)C_{ij}$$

$$Q_{ij} = \ln\left[\frac{r_i + r_j + d_{ij}}{r_i + r_j - d_{ij}}\right]$$

$$J_{ij} = \text{sgn}(Rij)[\tan^{-1}(|\frac{z}{R_{ij}}|\frac{S^j_{ij}}{r_j}) - \tan^{-1}(|\frac{z}{R_{ij}}|\frac{S^i_{ij}}{r_i})]$$

$$r_i = [(x - \xi_i)^2 + (y - \eta_i)^2 + z^2]^{1/2}$$

$$S^k_{ij} = (\xi_k - x)C_{ij} + (\eta_k - y)S_{ij}$$

$$C_{ij} = \frac{\xi_j - \xi_i}{d_{ij}}$$

$$S_{ij} = \frac{\eta_j - \eta_i}{d_{ij}}$$

$$d_{ij} = [(\xi_j - \xi_i)^2 + (\eta_j - \eta_i)^2]^{1/2}$$

At large distances from the element ($r_o/t > 4$), the element may be treated as a point source,. This greatly simplifies calculation of the velocity and potential:

$$\phi = \frac{I}{r_o} \qquad V_z = z\frac{I}{r_o^3}$$

$$V_\xi = \frac{x}{r_o^3} I \qquad I = \frac{1}{2}(\xi_3 - \xi_1)(\eta_2 - \eta_4)$$

$$V_\eta = \frac{y}{r_o^3} I$$

The equations for ϕ and $\overline{V}$ can be evaluated in any coordinate system. The final velocity components will be referenced to whatever system is used. At intermediate distances from the element, $2.45 < r_o/t < 4$, multipole expansions are used to evaluate the influence coefficients.

$$\phi = I_{00}w + \frac{1}{2}(I_{20}w_{xx} + 2I_{11}w_{xy} + I_{02}w_{yy})$$

$$V_\xi = -\frac{\partial\phi}{\partial x} = -I_{00}w_x - \frac{1}{2}(I_{20}w_{xxx} + 2I_{11}w_{xxy} + I_{02}w_{xyy})$$

$$V_\eta = -\frac{\partial\phi}{\partial y} = -I_{00}w_y - \frac{1}{2}(I_{20}w_{xxy} + 2I_{11}w_{xyy} + I_{02}w_{yyy})$$

$$V_\gamma = -\frac{\partial\phi}{\partial z} = -I_{00}w_z - \frac{1}{2}(I_{20}w_{xxz} + 2I_{11}w_{xyz} + I_{02}w_{yyz})$$

where:

$$w = r_o^{-1} \qquad w_{xxx} = 3x(3p + 10x^2)r_o^{-7}$$

$$w_x = -xr_o^{-3} \qquad w_{xxy} = 3ypr_o^{-7}$$

$$w_y = -yr_o^{-3} \qquad w_{xyy} = 3xqr_o^{-7}$$

$$w_z = -zr_o^{-3} \qquad w_{yyy} = 3y(3q + 10y^2)r_o^{-7}$$

$$w_{xx} = -(p + 2x^2)r_o^{-5} \qquad w_{xxz} = 3zpr_o^{-7}$$

$$w_{xy} = 3xyr_o^{-5} \qquad w_{xyz} = -15xyzr_o^{-7}$$

$$w_{yy} = -(q + 2y^2)r_o^{-5} \qquad w_{yyz} = 3zqr_o^{-7}$$

$$p = y^2 + z^2 - 4x^2 \qquad q = x^2 + z^2 - 4y^2.$$

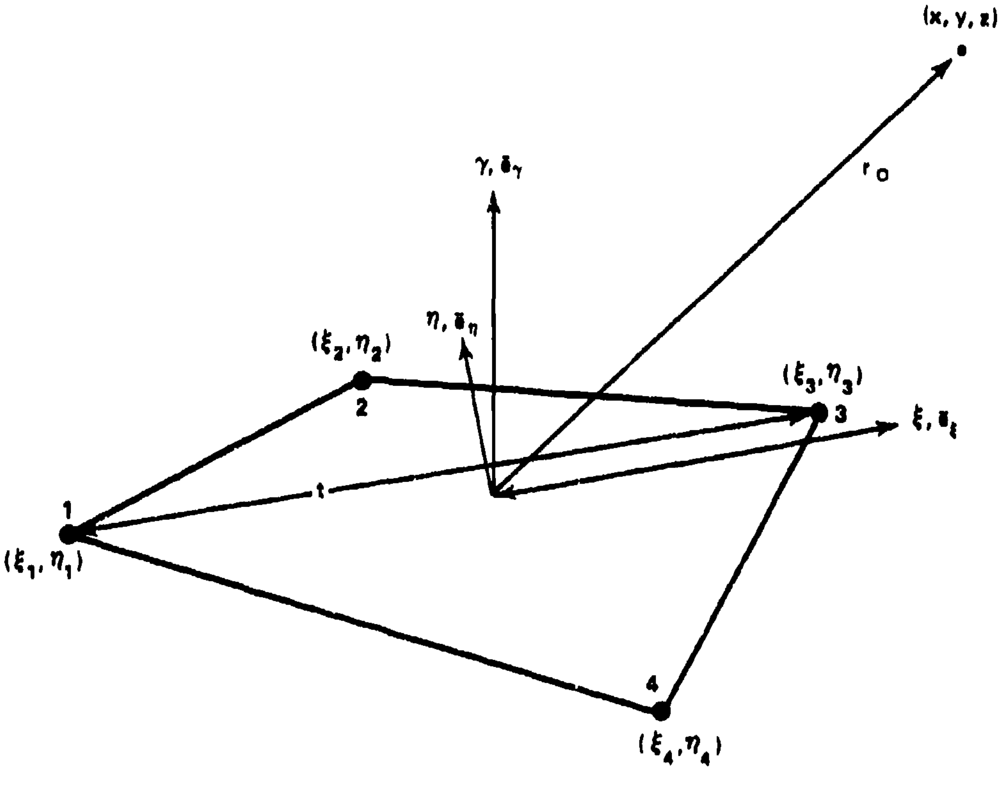

FIG. A-1 SYMBOLS

FIG. A-1 COORDINATE SYSTEM

APPENDIX B

DESCRIPTION OF THE COMPUTER PROGRAM

The computer program consists of the main routine, ENTRY, eighteen subroutines and one function. The flow chart for the program is given in Table B-1 and the main program variables are listed in Table B-2. A program listing is provided in Table B-3.

Program execution is initiated in ENTRY by calling subroutine INDATA which reads the required input (see Appendix C for a description of input cards). Based on options specified by the user a grid is set up on the surface of the model using subroutines STANG, LISTG, and OGIVG. Node points describing the surface of the body are stored in body (x', y', z') and water surface coordinates (x, y, z) in arrays X and XT respectively. The identification numbers of the four nodes defining the Jth element are stored in array IN(1, J), IN(2, J), IN(3, J) and IN(4, J). The coordinates of each node point, nodes making up each element and element centroids are printed in subroutine ELEMST. This terminates the element definition portion of the program which is executed only once.

The following sequence is executed at each step. The center of gravity of the entry body is inserted the prescribed increment in depth and the corresponding position of each node point is calculated by subroutine ADVN. Subroutine CREL is called which examines all elements to determine which are submerged. Elements split by the water surface are redefined using new node points which located on the water surface and stored at the ends of arrays X and XT. The nodes making up submerged elements are stored sequentially in array IT. The original reference number of each submerged element is stored in array IQ and the code indicating its state (i.e., modified, unmodified or split) in array IM. Upon completion of subroutine CREL, MAN is called which calculates the area, centroid and unit vectors of each element. If the PRINT option is used, element information is printed out by ELEMST for elements which are modified or unmodified for the first time. This information includes centroid and node locations in both coordinate systems, element areas and unit vector components. The arrays X, XT, IN, XC, XCP, VNO, E, IT, PHIO, IQ, IM are written on TAPE 15 by ENTRY. The coefficients of matrices A, B, C, and D are calculated by subroutine AMAT using the equations of Appendix A and written on TAPE 16. To determine the induced velocity normal to each element centroid (i.e., the right hand side of equation (13)) subroutine VNORM is called. The source strengths of equation (13) are calculated using DDECOMP and DSOLVE. These subroutines are called from SUAS which sets up matrix A in appropriate blocks using information on Tape 16. The element information stored on TAPE 15 and the matrices B, C, and D stored on TAPE 16 are recalled to allow velocity and potential values to be calculated at each centroid element in subroutine OUTPUT using equation (14). If the PRINT option is used, this information is also printed. Data necessary for calculating pressures and loads are stored on TAPE 17.

The above procedure is repeated until termination occurs. This can be triggered by reaching a step number greater than IMAX, having the number of submerged elements exceed NDIM, or having the computational time approach the job time limit. This last option is necessary since pressures and loads, of principal concern, are calculated at the end of the program. To insure that these quantities are computed the code estimates the amount of time required to complete each step before starting it. If the total estimated time estimated exceeds 90 percent of the job time limit, the flow field calculation is terminated and the program branches to subroutine PRESF which calculates pressures and loads using the equations (18) through (21).

TABLE B-1

PROGRAM FLOW CHART

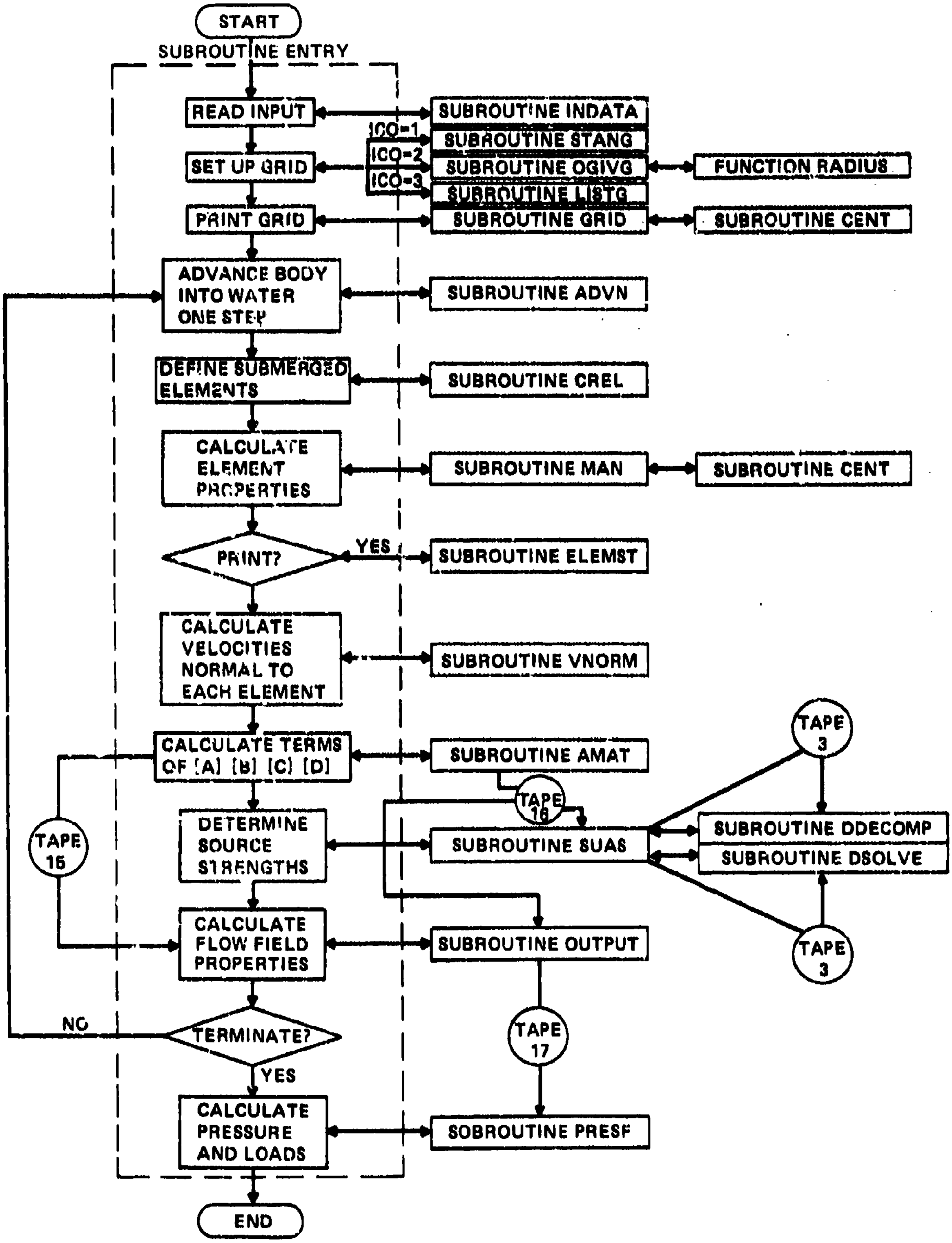

TABLE B-2

MAIN VARIABLES

VARIABLE	TYPE	DEFINITION
AN,AX,AY,ANS, AXS,AYS	ARRAY	TEMPORARY STORAGE IN AMAT AND OUTPUT
CGL	SIMPLE	z' COORDINATE OF CENTER OF GRAVITY
CW	ARRAY	WETTING FACTORS USE DURING CONSTANT ORIENTATION ENTRY
CWT(I)	ARRAY	WETTING FACTOR BETWEEN STEPS I-1 AND I
D	SIMPLE	MODEL DIAMETER. USED ONLY IN CALCULATING DIMENSIONLESS QUANTITIES
DT(I)	ARRAY	INCREMENT IN TIME BETWEEN STEPS I-1 AND I
E(I,J,K)	ARRAY	ELEMENT UNIT VECTORS. I = 1,2,3 ARE COMPONENTS ALONG x,y,z AXIS. J = 1,2,3 ARE UNIT VECTORS ξ, η, AND γ RESPECTIVELY. K IS ELEMENT NUMBER
HMIN	SIMPLE	INITIAL MODEL DEPTH
HMAX	SIMPLE	INCREASE IN MODEL DEPTH DUE TO RISING MOTION OF SURFACE
ICON	SIMPLE	IF ICON = 0, CONSTANT ORIENTATION ENTRY IS ASSUMED. IF ICON = 1 VARIABLE ORIENTATION IS USED
IEM	SIMPLE	NUMBER OF SUBMERGED ELEMENTS
IM(I)	ARRAY	I IS ELEMENT NUMBER, IM = 0, IM = 1, AND IM = 2, INDICATE NOT MODIFIED, MODIFIED AND SPLIT ELEMENTS RESPECTIVELY
IN(I,J)	ARRAY	NODES DEFINING CORNER LOCATIONS. I IS THE CORNER NUMBER AND J IS THE ELEMENT NUMBER
INP	SIMPLE	TOTAL NUMBER OF DEFINED NODES. INCLUDES NODES GENERATED TO DESCRIBE MODIFIED ELEMENTS
IP	ARRAY	USED IN DDECOMP AND DSOLVE

TABLE B-2 (Continued)

VARIABLE	TYPE	DEFINITION
IPRINT	SIMPLE	IF IPRINT = 1 PRINT OPTION IS EXERCISED
IPHI	SIMPLE	IF IPHI = 1 PLANAR SYMMETRY IS ASSUMED
IQ(K)	ARRAY	ORIGINAL IDENTIFICATION NUMBER OF SUBMERGED ELEMENTS. K IS THE IDENTIFICATION NUMBER OF THE SUBMERGED ELEMENT
IT(I,K)	ARRAY	IDENTIFICATION NUMBER OF NODES DESCRIBING THE Kth SUBMERGED ELEMENT
NCW	SIMPLE	NUMBER OF WETTING FACTORS TO BE USED DURING CONSTANT ORIENTATION ENTRY
NDIM	SIMPLE	MAXIMUM ALLOWABLE NUMBER OF SUBMERGED ELEMENTS
NEL	SIMPLE	NUMBER OF ELEMENTS INITIALLY DEFINED
PHI	ARRAY	TEMPORARY STORAGE IN AMAT
PHIS	ARRAY	TEMPORARY STORAGE IN OUTPUT
SIG(K)	ARRAY	SOURCE STRENGTH OF ELEMENT K
STOR	ARRAY	TEMPORARY STORAGE IN SUAS
SUMT	SIMPLE	90 PERCENT OF TIME LIMIT
VENTRY	SIMPLE	ENTRY VELOCITY
VEX(I),VEY(I), VEZ(I)	ARRAY	VELOCITY COMPONENTS IN THE x,y, AND z DIRECTION USED BETWEEN STEPS I and I-1
VNO(I)	ARRAY	VELOCITY NORMAL TO ELEMENT I
WX(I)	ARRAY	ANGULAR VELOCITY IN THE PITCH PLANE BETWEEN STEPS I AND I-1
X(I,K)	ARRAY	COORDINATES OF THE Kth NODE. I = 1,2,3 REFER TO THE x',y',z' AXES RESPECTIVELY
XC(I,K)	ARRAY	COORDINATES OF THE CENTROID OF THE Kth ELEMENT. I = 1,2,3 REFER TO THE x',y', AND z' AXES RESPECTIVELY

TABLE B-2 (Continued)

VARIABLE	TYPE	DEFINITION
XCP(I,K)	ARRAY	COORDINATES OF THE CENTROID OF THE Kth ELEMENT. I = 1,2,3 REFER TO THE x,y, AND z AXIS RESPECTIVELY
XCPB(I)	ARRAY	COORDINATES OF THE CENTER OF GRAVITY. I = 1,2,3 REFER TO THE x,y,z AXES RESPECTIVELY
XT(I,K)	ARRAY	COORDINATES OF THE Kth NODE. I = 1,2,3 REFER TO THE x,y,z AXES

```
PROGRAM ENTRY       73/73    OPT=1                         FTN 4.5+410        77/01/17. 11.07.10        PAGE     1

            PROGRAM ENTRY(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE15=512,     ENTRY      2
           *TAPE16=512,TAPE17=512,TAPE3)                                         DEC02      1
            COMMON A(120,120),SIG(300),IP(300)                                   JAN01      1
            DIMENSION X(3,1),XT(3,1),XC(3,1),XCP(3,1),VNO(1),PHIO(2,1),          ENTRY      5
           *E(3,3,1),IN(4,1),IT(4,1),IO(1),IM(1),AN(1),AX(1),                    ENTRY      6
           *AY(1),PHI(1),ANS(1),AXS(1),AYS(1),PHIS(1),CW(20),                    ENTRY      7
           *VEZ(50),VEY(50),VEX(50),WX(50),DT(50),XCPR(3),CWT(50)                NOV03      1
           *,IGRID(1),STOR(1),INDEX(20)                                          DEC06      1
C.....EQUIVALENCE STATEMENTS                                                     DEC01      3
C.....THE A ARRAY IS SET UP TO HANDLE 300 SUBMERGED ELEMENTS.                    DEC01      4
C.....SPECIFIED GRID MAY BE AS LARGE AS 500 ELEMENTS AND 800 NODES.              DEC01      5
C.....EXECUTION WILL TERMINATE WHEN MORE THAN THREE HUNDRED OF THESE             DEC01      6
C.....ELEMENTS ARE SUBMERGED.                                                    DEC01      7
C.....MASS STORAGE IS SET UP FOR A MAXIMUM OF 19 DATA BLOCKS.                    DEC01      8
C.....NDIM=MAXIMUM NUMBER OF SUBMERGED ELEMENTS.                                 DEC01      9
C.....MNPT=MAXIMUM NUMBER OF NODES                                               DEC01     10
C.....MNEL=MAXIMUM NUMBER OF ELEMENTS.                                           DEC01     11
C.....NBLK=DIMENSION OF A ARRAY                                                  JAN01      2
C.....PRIMARY A ARRAY STORAGE                                                    DEC01     12
C.....         A(1),X(1)                                                         DEC01     13
C.....         A(3*MNPT+1),XT(1)                                                 DEC01     14
C.....         A(6*MNPT+1),IN(1)                                                 DEC01     15
C.....         A(6*MNPT+4*MNEL+1),XC(1)                                          DEC01     16
C.....         A(6*MNPT+4*MNEL+3*NDIM+1),XCP(1)                                  DEC01     17
C.....         A(6*MNPT+4*MNEL+6*NDIM+1),VNO(1)                                  DEC01     18
C.....         A(6*MNPT+4*MNEL+7*NDIM+1),E(1)                                    DEC01     19
C.....         A(6*MNPT+4*MNEL+16*NDIM+1),IT(1)                                  DEC01     20
C.....         A(6*MNPT+4*MNEL+20*NDIM+1),PHIO(1)                                DEC01     21
C.....         A(6*MNPT+6*MNEL+20*NDIM+1),IO(1)                                  DEC01     22
C.....         A(6*MNPT+6*MNEL+21*NDIM+1),STOR(1)                                DEC01     23
C.....MAXIMUM STORAGE REQUIREMENT FOR A IS 6*MNPT+6*MNEL+22*NDIM.                DEC01     24
C.....SECONDARY STORAGE FOR A ARRAY                                              DEC01     25
C.....         A(1),AN(1)                                                        DEC01     26
C.....         A(NDIM+1),AX(1)                                                   DEC01     27
C.....         A(2*NDIM+1),AY(1)                                                 DEC01     28
C.....         A(3*NDIM+1),PHI(1)                                                DEC01     29
C.....         A(4*NDIM+1),ANS(1)                                                DEC01     30
C.....         A(6*NDIM+1),AXS(1)                                                DEC01     31
C.....         A(6*NDIM+1),AYS(1)                                                DEC01     32
C.....         A(7*NDIM+1),PHIS(1)                                               DEC01     33
C.....TOTAL STORAGE REQUIREMENTS ARE 8*NDIM                                      DEC01     34
            EQUIVALENCE (A(1),X(1)),(A(2401),XT(1)),(A(4801),IN(1)),             DEC01     35
           *(A(6801),XC(1)),(A(7701),XCP(1)),(A(8601),VNO(1)),(A(8901),E(1)),    DEC01     36
           *(A(11601),IT(1)),(A(12801),PHIO(1)),(A(13801),IO(1)),                DEC27      1
           *(A(14101),STOR(1))                                                   DEC01     38
            EQUIVALENCE (A(1),AN(1)),(A(301),AX(1)),(A(601),AY(1)),              DEC01     39
           *(A(901),PHI(1)),(A(1201),ANS(1)),(A(1501),AXS(1)),(A(1801),AYS(1))   DEC01     40
           *,(A(2101),PHIS(1))                                                   DEC01     41
            EQUIVALENCE(IP(1),IM(1))                                             ENTRY     25
C.....STORAGE CONSTANTS                                                          DEC01     42
            NDIM=300                                                             DEC01     43
            NPT=NEL=0                                                            DEC03      1
            ZTC=YTC=0.0                                                          DEC03      2
            NBLK=120                                                             JAN01      3
            IAVS=NBLK*NBLK/2                                                     JAN01      4
            CALL OPENMS(3,INDEX,19,0)                                            DEC03      3
C.....READ IN OPTIONS                                                            ENTRY     39
```

```
      CALL INDATA(IPRINT,IPHI,INODE,IGRID,IMAX,HMIN,ICON,SUMT,           ENTRY     40
     *SUMF,D,DT,CWT,CW,VEZ,VEY,VEX,WX,ANG,XCPB,CGL,VENTRY,NCW,NNLD,FCF)  DEC27      4
                                                                         ENTRY     42
C.....SET UP GRID                                                        DEC06      2
      NN=IGRID(1)+1                                                      DEC06      3
      DO 4 II=2,NN                                                       DEC06      4
      ICO=IGRID(II)                                                      DEC06      5
      IF(ICO.EQ.1)CALL STANG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)     DEC06      6
      IF(ICO.EQ.2)CALL OGIVG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)     JAN10      2
      IF(ICO.EQ.3)CALL LISTG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)     DEC06      9
    4 CONTINUE                                                           DEC14      3
      CALL GRID(NPT,NEL,X,XT,IN,PHIO,XC,ACHECK,NNLD)                     ENTRY     48
C.....SET MISCELLANEOUS CONSTANTS                                        NOV03      5
      ISTEP=0                                                            ENTRY     49
      CPC=0.0                                                            ENTRY     50
      SUM=SECOND(AQ)                                                     ENTRY     51
      DO 15 J=1,2                                                        ENTRY     52
      DO 15 I=1,NEL                                                      ENTRY     53
   15 PHIO(J,I)=0.0                                                      ENTRY     54
C.....MAIN LOOP                                                          ENTRY     55
   20 ISTEP=ISTEP+1                                                      ENTRY     56
      IF(ISTEP.NE.1)READ(15)A                                            ENTRY     57
      REWIND 15                                                          ENTRY     58
C.....ADVANCE ALL NODES                                                  NOV03      6
      CALL ADVN(XT,VEZ,VEY,VEX,CWT,WX,ANG,XCPB,ISTEP,NPT,DT,DDZ,         NOV03      7
     *HMAX)                                                              ENTRY     60
C.....DETERMINE WHICH ELEMENTS ARE VALID                                 NOV15      2
      CALL CREL(X,IN,IT,IQ,IM,IEM,NPT,NEL,ANG,INP,XT,XCPB,CGL,ACHECK)    ENTRY     62
      IF(IEM.GT.NDIM)GO TO 21                                            ENTRY     63
C.....CALCULATE ELEMENT VECTORS,CENTROIDS AND TRANSFORM NODES FROM       ENTRY     64
C.....BODY TO WATER COORDINATES                                          NOV05      1
      CALL MAN(X,IT,XT,XC,XCP,IEM,ANG,PHIO,IQ,XCPB,CGL,E)                ENTRY     66
      XIEM2=IEM*IEM                                                      ENTRY     67
      IF(CPC*XIEM2+SUM+SUMF.GT.SUMT)GO TO 21                             JAN10      3
      IF(IPRINT.EQ.1.AND.NPT.NE.INP)CALL ELEMST(INP,NPT,IT,IEM,IQ,IM,    JAN10      4
     1X,XT,XC,XCP,E,PHIO,ISTEP,HMAX)                                     NOV08      2
      CALL VNORM(VEZ,VEY,VEX,WX,VNO,E,IEM,ISTEP,XCP,XCPB,IPRINT)         ENTRY     70
      WRITE(15)A,IP                                                      ENTRY     71
      REWIND 15                                                          ENTRY     72
C.....CALCULATE MATRICES                                                 NOV09      1
      CALL AMAT(XCP,XT,IT,IEM,AN,AY,AX,PHI,VNO,F,IPHI)                   ENTRY     74
C.....INVERT MATIX AND DETERMINE SOURCE STRENGTHS                        JAN01      5
      CALL SUAS(IEM,IAVS,NBLK,A,IP,VNO,SIG,STOR)                         ENTRY     90
C.....CALCULATE FLOW QUANTITIES                                          ENTRY     91
      READ(15)A,IP                                                       ENTRY     92
      REWIND 15                                                          NOV03     10
      CALL OUTPUT(IEM,IT,IN,ANG,SIG,VNO,AN,ANS,AX,AXS,AY,AYS,PHI,PHIS,   NOV03     11
     *PHIO,XC,XCP,IQ,IM,E,IPRINT,DDZ,HMAX,XCPB)                          ENTRY     95
C.....TERMINATE CHECK                                                    ENTRY     96
      SUMP=SUM                                                           ENTRY     97
      SUM=SECOND(AQ)                                                     ENTRY     98
      SUMD=SUM-SUMP                                                      ENTRY     99
      CPC=SUMD/XIEM2                                                     ENTRY    100
      IF(IPRINT.EQ.1)WRITE(6,2031)SUMD                                   ENTRY    101
      IF(IPRINT.EQ.0)WRITE(6,2032)ISTEP,SUMD                             ENTRY    102
 2032 FORMAT(1H0,5HSTEP ,I5,30H COMPLETE.CP TIME FOR STEP IS ,F10.5)     ENTRY    103
 2031 FORMAT(1H0,20X,18HCP TIME FOR CYCLE ,F10.5)                        ENTRY    104
      IF(SUMT-SUM.LT.SUMF)GO TO 22
```

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PROGRAM ENTRY       73/73   OPT=1                          FTN 4.5+410       77/01/17. 11.07.10       PAGE      3

              IF(ISTEP.LE.IMAX)GO TO 20                                          NOV03       12
           22 ISTEP=ISTEP+1                                                      ENTRY      106
           21 CONTINUE                                                           ENTRY      107
              REWIND 17                                                          ENTRY      108
      C.....CALCULATE PRESSURE AND FORCES                                        ENTRY      109
              CALL PRESF(ISTEP,IMODE,WX,VEZ,VEY,VEX,HMIN,CW,DT,ICON,CWT,         ENTRY      110
             *CGL,NCW,D,VENTRY,IPHI,NNLD,FCF)                                    JAN10        5
              STOP                                                               ENTRY      112
              END                                                                ENTRY      113
```

```
      SUBROUTINE INDATA(IPRINT,IPHI,IMODE,IGRID,IMAX,HMIN,ICON,SUMT,   INDATA   2
     *SUMF,D,DT,CWT,CW,VEZ,VEY,VEX,WX,ANG,XCPB,CGL,VENTRY,NCW,NNLD,FCF)  DEC27  7
      DIMENSION DT(1),CWT(1),CW(1),VEZ(1),VEY(1),VEX(1),WX(1),XCPB(1)  NOV03   14
     *,IGRID(1)                                                        DEC06   10
C.....READ IN OPTIONS                                                  INDATA   5
      EPS=1.-06                                                        JAN10    6
      CONVR=57.29577951                                                DEC06   11
      NCW=1                                                            INDATA   6
      IMODE=0                                                          DEC06   12
      READ(5,1000)CON1,CON2                                            DEC06   13
      ICON=1                                                           DEC06   14
      IF(CON1.EQ.4HCONS)ICON=0                                         DEC06   15
      WRITE(6,1999)CON1,CON2                                           DEC06   16
 1999 FORMAT(1H1,36X,29H*******PROGRAM OPTIONS*******/1H,36X,2A4,* BODY DEC06  17
     *ORIENTATION*)                                                    DEC06   18
      READ(5,1000)CON1,CON2,CON3                                       DEC06   19
      IPRINT=0                                                         INDATA   8
      IF(CON1.EQ.4HPRIN)IPRINT=1                                       DEC06   20
      WRITE(6,1998)CON1,CON2,CON3                                      DEC06   21
 1998 FORMAT(1H ,36X,3A4)                                              DEC06   22
      READ(5,1000)CON1,CON2,CON3                                       DEC06   23
      IPHI=1                                                           INDATA  13
      IF(CON1.EQ.4HASYM)IPHI=2                                         DEC06   24
      WRITE(6,1997)CON1,CON2,CON3                                      DEC06   25
 1997 FORMAT(1H ,36X,2A4,A2,* CONFIGURATION*)                          DEC06   26
C.....READ IN CONTROL PARAMETERS                                       INDATA  26
      READ(5,1003)IMAX,D,VENTRY,ANG,SUMT,HMIN,DH,ALPHA                 DEC06   27
      READ(5,1004)CGL,FCF,ANGBB,NNLD                                   DEC27    8
      IF(NNLD.EQ.0)NNLD=10000                                          DEC14    8
      WRITE(6,2000)                                                    INDATA  29
 2000 FORMAT(1H0,34X,32H*******PROBLEM PARAMETERS*******)              NOV02    3
      WRITE(6,2001)D                                                   INDATA  31
 2001 FORMAT(1H ,40X,9HDIAMETER ,F6.4,3H FT)                           INDATA  32
      WRITE(6,2021)VENTRY                                              INDATA  33
 2021 FORMAT(1H ,46X,15HENTRY VELOCITY ,F10.3,8H(FT/SEC))              INDATA  34
      WRITE(6,2004)ANG                                                 INDATA  35
 2004 FORMAT(1H ,40X,*BODY ORIENTATION ANGLE *,F6.2,8H DEGREES)        INDATA  36
      WRITE(6,2005)HMIN,IMAX                                           INDATA  38
 2005 FORMAT(1H ,30X,13HINITIAL DEPTH ,[illegible].5,3H FT,*   TERMINATION STEP* NOV03  17
     *,I3)                                                             NOV03   18
      IF(FCF.LT.1.E-02)FCF=1.                                          DEC27    9
      IF(HMIN.GT.1.E-08)IMAX=IMAX+1                                    DEC27   10
      WRITE(6,2009)FCF                                                 DEC27   11
 2009 FORMAT(1H ,33X,*INITIAL PRESSURE CORRECTION FACTOR = *,F7.4)     DEC27   12
      SUMF=SUMT*.1                                                     NOV05    5
      XCPB(1)=XCPB(2)=0.0                                              INDATA  42
      XCPB(3)=CGL                                                      INDATA  43
      WRITE(6,2008)XCPB(1),XCPB(2),XCPB(3)                             INDATA  44
 2008 FORMAT(1H ,19X,*CENTROIDE COORDINATES *,3(2X,F16.5))             INDATA  45
      IF(ICON.NE.0)GO TO 30                                            DEC06   28
C.....CONSTANT VELOCITY                                                DEC06   29
      WRITE(6,2C92)DH                                                  DEC06   30
      WRITE(6,2003)ALPHA                                               DEC06   31
      WRITE(6,2010)ANGBB                                               DEC27   13
 2002 FORMAT(1H ,38X,*INCREMENT IN DEPTH *,F10.7)                      DEC06   32
 2003 FORMAT(1H ,45X,*ANGLE OF ATTACK *,[illegible].2)                 DEC06   33
 2010 FORMAT(1H ,43X,*YAW ANGLE *,F7.2)                                DEC27   14
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SUBROUTINE INDATA      73/73    OPT=1                        FTN 4.5+410        77/01/17. 11.07.10        PAGE     2

          READ(5,1002)NCW,(CW(I),I=1,NCW)                                              DEC06      34
          WRITE(6,2022)(CW(I),I=1,NCW)                                                 DEC06      35
          NVP=1                                                                        DEC06      36
          VEX(1)=SIN(ANGBB/CONVR)*VENTRY                                               DEC27      15
          VEY(1)=-COS(ANGBB/CONVR)*COS((ANG+ALPHA)/CONVR)*VENTRY                       DEC27      16
          VEZ(1)=-COS(ANGBB/CONVR)*SIN((ANG+ALPHA)/CONVR)*VENTRY                       DEC27      17
          WX(1)=0.0                                                                    DEC06      40
          DT(1)=-DH/(VEZ(1)*CW(1))                                                     DEC06      41
          CWT(1)=CW(1)                                                                 DEC06      42
          GO TO 4?                                                                     DEC06      43
C.....VARIABLE ENTRY VELOCITY                                                           DEC06      44
 2022 FORMAT(1H0,40X,15HWETTING FACTORS/(43X,F10.5))                                   INDATA     47
C.....READ IN VELOCITY HISTORY                                                          INDATA     48
   30 CONTINUE                                                                         DEC06      45
          NCW=1                                                                        DEC14       9
          READ(5,1002)NVP                                                              INDATA     49
          WRITE(6,2006)                                                                INDATA     50
          DO 10 I=1,NVP                                                                INDATA     51
          READ(5,1001)VEX(I),VEY(I),VEZ(I),WX(I),CW~(I),DT(I)                          NOV03      19
          WRITE(6,2007)I,VEX(I),VEY(I),VEZ(I),WX(I),CWT(I),DT(I)                       NOV03      20
          DT(I)=-DT(I)/(CWT(I)*VEZ(I))                                                 DEC15       1
   10 CONTINUE                                                                         INDATA     54
 2007 FORMAT(1H ,25X,I5,3F10.4,F10.1,2F10.6)                                           NOV08       3
 2006 FORMAT(1H0,27X,*NO*,7X,*VX*,8X,*VY*,8X,*VZ*,8X,*WX*,8X,*CWT*,8X,                 INDATA     56
     1*H*)                                                                             DEC15       2
C.....DEFINE CONDITIONS FOR EACH STEP                                                    DEC06      46
   40 NVP1=NVP+1                                                                       DEC06      47
          DO 20 I=NVP1,50                                                              INDATA     59
          VEX(I)=VEX(NVP)                                                              NOV03      21
          VEY(I)=VEY(NVP)                                                              NOV03      22
          VEZ(I)=VEZ(NVP)                                                              NOV03      23
          WX(I)=WX(NVP)                                                                INDATA     63
          CWT(I)=CWT(NVP)                                                              INDATA     64
   20 DT(I)=DT(NVP)                                                                    INDATA     65
          DT(I)=DT(I)*(1.+EPS)                                                         JAN19       7
C.....GRID OPTIONS                                                                      DEC06      48
          READ(5,1002)N                                                                DEC06      49
          IGRID(1)=N                                                                   DEC06      50
          WRITE(6,1996)                                                                DEC06      51
          DO 70 I=1,N                                                                  DEC06      52
          I1=I+1                                                                       DEC06      53
          IGRID(I1)=1                                                                  DEC06      54
          READ(5,1000)GRID,GRID2,GRID3                                                 DEC06      55
          IF(GRID.EQ.4HOGIV)IGRID(I1)=2                                                DEC06      56
          IF(GRID.EQ.4HLIST)IGRID(I1)=3                                                JAN10       8
          WRITE(6,1995)GRID,GRID2,GRID3                                                DEC06      59
   ?0 CONTINUE                                                                         DEC06      60
 1995 FORMAT(1H ,40X,3A4)                                                              DEC06      61
 1996 FORMAT(1H0,34X,26H*******GRID OPTIONS*******)                                    DEC06      62
 1000 FORMAT(12A4)                                                                     DEC06      63
 1001 FORMAT(8F10.0)                                                                   INDATA     68
 1002 FORMAT(I5,5X,7F10.0/(8F10.0))                                                    INDATA     69
 1003 FORMAT(I5,5X,7F10.0)                                                             DEC06      64
 1004 FORMAT(3F10.0,I5)                                                                DEC27      18
          END                                                                          INDATA     70
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     SUBROUTINE INDATA     73/73   OPT=1                       FTN 4.5+410      77/01/17. 11.07,10      PAGE    3

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

      46      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
      47      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
      48      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
      48      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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SUBROUTINE STANG        73/73    OPT=1                    FTN 4.5+410        77/01/17. 11.07.10        PAGE    1

              SUBROUTINE STANG(NPT,NEL,ANG,T,XT,IN,XCPB,HMIN,ZTC,YT)                     DEC06     65
              DIMENSION  (20),Z(20),IW(20),X(3,1),XT(3,1),IN(4,1),XCPB(1)                STANG      3
        C.....IW(I)=NUMBER OF ELEMENTS IN THE ITH ROW.IF IW(I)=0,THIS NUMBER            STANG      4
        C.....IS COMPUTED TO OBTAIN APPROXIMATELY SQUARE ELEMENTS WHICH ARE A           STANG      5
        C.....MULTIPLE OF IW(I-1).                                                      STANG      6
              NPT1=NPT+1                                                                 NOV11     17
              CONVR=57.29577951                                                          STANG      7
              PIE=180./CONVR                                                             STANG      8
              READ(5,1004)NROWS,IANG,ISUP                                                DEC06     66
              XANG=IANG+1                                                                NOV11     19
         1004 FORMAT(4I5)                                                                NOV11     20
              WRITE(6,2040)                                                              STANG     11
         2040 FORMAT(1H0,50X,9HGRID SIZE/1H ,46X,1HR,11X,1HZ,4X,6HNUMBER)                STANG     12
              SINE=SIN(ANG/CONVR)                                                        STANG     13
              COSE=COS(ANG/CONVR)                                                        STANG     14
              R(1)=Z(1)=0.0                                                              STANG     15
              NRWP=NROWS+1                                                               STANG     17
              NLR=0                                                                      DEC27     19
              DO 8 IB=2,NRWP                                                             STANG     18
              READ(5,1001)R(IB),Z(IB),IW(IB)                                             STANG     19
              WRITE(6,2041)R(IB),Z(IB),IW(IB)                                            STANG     20
              IF(IW(IB).LT.0)NLR=1                                                       DEC27     20
              IW(IB-1)=IABS(IW(IB))                                                      DEC27     21
              IF(NLR.EQ.1)GO TO 8                                                        DEC27     22
              IF(NPT1.NE.1)GO TO 8                                                       NOV11     21
              ZBL=Z(IB)*SINE-R(IB)*COSE                                                  STANG     22
              IF(ZBL.GE.-ZTC)GO TO 8                                                     NOV11     22
              ZTC=-ZBL                                                                   NOV11     23
              YT=Z(IB)*COSE+R(IB)*SINE                                                   STANG     25
            8 CONTINUE                                                                   STANG     26
              IW(1)=3*(IANG+1)                                                           NOV11     24
         1001 FORMAT(2F10.0,I5)                                                          STANG     29
         2041 FORMAT(1H ,37X,2(F10.6,4X),I5)                                             STANG     30
              DO 10 I=1,NROWS                                                            STANG     32
              IF(IW(I).GT.0)GO TO 15                                                     STANG     33
              AVG=(R(I)+R(I+1))/2.                                                       STANG     34
              SL=SQRT((R(I)-R(I+1))**2+(Z(I)-Z(I+1))**2)                                 STANG     35
              XW=PIE*AVG/SL+1.                                                           STANG     36
              IW(I)=XW*XANG                                                              NOV11     25
           15 CONTINUE                                                                   STANG     38
              IWH=IW(I)+1                                                                STANG     39
              XWH=IWH-1                                                                  STANG     40
              NGO=2                                                                      STANG     41
              IF(I.EQ.1)GO TO 16                                                         STANG     42
              IF(IW(I).EQ.IW(I-1))GO TO 16                                               STANG     43
              NGO=1                                                                      STANG     44
           16 CONTINUE                                                                   STANG     45
              DO 40 JK=NGO,2                                                             STANG     46
              ZZ=Z(I+JK-1)                                                               STANG     47
              RR=R(I+JK-1)                                                               STANG     48
              DO 30 K=1,IWH                                                              STANG     49
              XK=K-1                                                                     STANG     50
              AN=PIE*XK/XWH*XANG                                                         NOV11     26
              NPT=NPT+1                                                                  STANG     52
              X(3,NPT)=ZZ                                                                STANG     53
              X(2,NPT)=-COS(AN)*RR                                                       STANG     54
              X(1,NPT)=SIN(AN)*RR                                                        STANG     55
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SUBROUTINE STANG      73/73    OPT=1                     FTN 4.5+410        77/01/17. 11.07.10        PAGE     2

             30 CONTINUE                                                     STANG      56
             40 CONTINUE                                                     STANG      57
             10 CONTINUE                                                     STANG      58
                SINE=SIN(ANG*PIE/180.)                                       STANG      59
                COSE=COS(ANG*PIE/180.)                                       STANG      60
                DO 20 I=NPT1,NPT                                             NOV11      21
                XT(3,I)=X(3,I)*SINE-X(2,I)*COSE+ZTC-HMIN                     NOV08       4
                XT(2,I)=X(3,I)*COSE+X(2,I)*SINE-YT                           STANG      63
                XT(1,I)=X(1,I)                                               STANG      64
             20 CONTINUE                                                     STANG      65
                IF(NPT1.NE.1)GO TO 52                                        NOV15       3
                GZ= XCPB(3)*SINE-XCPB(2)*COSE+ZTC-HMIN                       STANG      68
                GY=XCPB(3)*COSE+XCPB(2)*SINE-YT                              STANG      69
                XCPB(3)=GZ                                                   STANG      70
                XCPB(2)=GY                                                   STANG      71
             52 CONTINUE                                                     NOV15       4
                IF(ISUP.EQ.1)GO TO 51                                        NOV03      24
                IN(1,1)=1                                                    STANG      72
                IN(2,1)=2                                                    STANG      73
                IN(3,1)=3                                                    STANG      74
                IN(4,1)=4                                                    STANG      75
                NEL=NEL+1                                                    NOV11      28
                IF(IANG.EQ.0)GO TO 51                                        NOV11      29
                IN(1,2)=7                                                    NOV11      30
                IN(2,2)=4                                                    NOV11      31
                IN(3,2)=5                                                    NOV11      32
                IN(4,2)=6                                                    NOV11      33
                NEL=NEL+1                                                    NOV11      34
             51 SUM=NPT1                                                     NOV11      35
                DO 50 K=2,NROWS                                              STANG      78
                SUM=SUM+IW(K-1)+1                                            STANG      79
                IF(IW(K).NE.IW(K-1))SUM=SUM+IW(K)+1                          STANG      80
                SUMP=SUM-IW(K)-1                                             STANG      81
                IWK=IW(K)                                                    STANG      82
                DO 50 I=1,IWK                                                STANG      83
                NEL=NEL+1                                                    STANG      84
                IN(1,NEL)=SUM+I-1                                            STANG      85
                IN(2,NEL)=SUM+I                                              STANG      86
                IN(3,NEL)=SUMP+I                                             STANG      87
             50 IN(4,NEL)=SUMP+I-1                                           STANG      88
                RETURN                                                       STANG      89
                END                                                          STANG      90

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

     69      I      XCPB     ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     69      I      XCPB     ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     70      I      XCPB     ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     70      I      XCPB     ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     71      I      XCPB     ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     72      I      XCPB     ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     81      I      IN       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     82      I      IN       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     83      I      IN       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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        SUBROUTINE STANG      73/73   OPT=1                      FTN 4.5+410        77/01/17. 11.07.10       PAGE

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM
     84     I        IN      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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      SUBROUTINE OGIVG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)             DEC06   67
      DIMENSION X(3,1),XT(3,1),XCPB(3),IN(4,1),H(50),IW(50),B(50)         NOV23    1
C.....SUBROUTINE APPLICABLE TO AXISYMMETRIC BODIES WITH A POINTED NOSE.   NOV23    2
C.....USER PROVIDES GRID HEIGHT ON THE WINDWARD RAY OF THE BODY.          NOV23    3
C.....BODY ORIENTATION AND NUMBER OF ELEMENTS IN EACH ROW ARE ALSO        NOV23    4
C.....SPECIFIED.  NOTE- BODY SLOPE AT EACH RING MUST BE GREATER THAN      NOV23    5
C.....THAT OF THE BODY ORIENTATION.                                       NOV23    6
      COMMON/RAD/NBODY,R(50),Z(50)                                        NOV23    7
      NPT1=NPT+1                                                          NOV24    1
      IF(NPT1.EQ.1)ZTC=YTC=0.0                                            NOV23    9
      CONVR=57.29577951                                                   NOV23   10
      SINE=SIN(ANG/CONVR)                                                 NOV23   11
      COSE=COS(ANG/CONVR)                                                 NOV23   12
C.....READ IN DATA                                                        NOV23   13
      READ(5,1000)NROWS,NBODY,IANG                                        DEC06   68
      NROWS=NROWS+1                                                       NOV23   15
      XANG=IANG+1                                                         NOV23   16
 1000 FORMAT(4I5)                                                         NOV23   17
      WRITE(6,2000)IANG                                                   NOV23   18
 2000 FORMAT(1H0,40X,*SYMMETRY = *,I5)                                    NOV23   19
      READ(5,1001)(R(I),Z(I),I=1,NBODY)                                   NOV23   20
 1001 FORMAT(2F10.0)                                                      NOV23   21
      WRITE(6,2001)                                                       NOV23   22
 2001 FORMAT(1H ,50X,*BODY PROFILE*/1H ,46X,1HR,11X,1HZ)                  NOV23   23
      WRITE(6,2002)(R(I),Z(I),I=1,NBODY)                                  NOV23   24
 2002 FORMAT(1H ,37X,F10.6,4X,F10.6)                                      NOV23   25
      READ(5,1002)(H(I),B(I),IW(I),I=2,NROWS)                             NOV23   26
 1002 FORMAT(2F10.0,I5)                                                   NOV23   27
      WRITE(6,2003)                                                       NOV23   28
 2003 FORMAT(1H ,50X,9HGRID SIZE/1H ,46X,1HH,11X,1HB,4X,6HNUMBER)         NOV23   29
      WRITE(6,2004)(H(I),B(I),IW(I),I=2,NROWS)                            NOV23   30
 2004 FORMAT(1H ,37X,F10.6,4X,F10.6,4X,I5)                                NOV23   31
C.....CONSTRUCT NODES                                                     NOV23   32
      I=NBODY                                                             NOV23   33
      R(I+1)=1000.                                                        NOV23   35
      Z(I+1)=Z(I)+(Z(I)-Z(I-1))*(R(I+1)-R(I))/(R(I)-R(I-1))               NOV23   36
      H(1)=H(2)/1000.                                                     NOV23   37
      IW(1)=IW(2)                                                         NOV23   38
      B(1)=90.                                                            NOV23   39
      SGNP=1.                                                             NOV23   40
      RP1=RP2=0.0                                                         NOV24    2
      DO 10 I=1,NROWS                                                     NOV23   42
      TANB=TAN((90.-B(I))/CONVR)                                          NOV23   43
      XW=IW(I)                                                            NOV23   44
      IWK=IW(I)+1                                                         NOV23   45
      YO=RADIUS(H(I))                                                     NOV23   46
      ZO=H(I)                                                             NOV23   47
      SGN=1.                                                              NOV23   48
      RG=ZO                                                               NOV23   49
      ERR=ERR1=1.E-08                                                     NOV23   50
      DT=180.*XANG/(CONVR*XW)                                             NOV23   51
      DO 10 K=1,IWK                                                       NOV23   52
      DRG=RG/10.                                                          NOV23   53
      NPT=NPT+1                                                           NOV23   54
      XK=K-1                                                              NOV23   55
      IC=0                                                                NOV23   56
      ITP=0                                                               NOV23   57
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SUBROUTINE OGIVE      73/73    OPT=1                    FTN 4.5+410        77/01/17. 11.07.10        PAGE     2

            T=DT*XK                                                      NOV23     58
            COST=COS(T)                                                  NOV23     59
         14 RG=RG+SGN*DRG                                                NOV23     60
         16 IC=IC+1                                                      NOV23     61
            IF(IC.GT.100)STOP                                            NOV23     62
            Y=-RG*COST                                                   NOV23     63
            ZZ=Z0+(Y-Y0)*TANB                                            NOV23     64
            ERR=RADIUS(ZZ)-RG                                            NOV23     65
            IF(ABS(ERR).LT.RG/10000.)GO TO 15                            NOV23     58
            SGNP=SGN                                                     NOV23     69
            SGN=1.                                                       NOV23     70
            IF(ERR.LT.0.0)SGN=-1.                                        NOV23     71
            RP2=RP1                                                      NOV23     73
            ERR2=ERR1                                                    NOV23     74
            RP1=RG                                                       NOV23     75
            ERR1=ERR                                                     NOV23     76
            IF(IC.EQ.1)GO TO 14                                          NOV23     77
            IF(ITP.EQ.1)GO TO 17                                         NOV23     78
            IF(ERR1*ERR2.GT.0.0)GO TO 14                                 NOV24      3
         17 ITP=1                                                        NOV23     80
            RG=RP1-(RP2-RP1)*ERR1/(ERR2-ERR1)                            NOV24      4
            GO TO 16                                                     NOV23     82
         15 X(1,NPT)=RG*SIN(T)                                           NOV23     83
            X(2,NPT)=Y                                                   NOV23     84
         10 X(3,NPT)=ZZ                                                  NOV23     85
            DO 21 I=NPT1,NPT                                             NOV24      5
            XT(3,I)=X(3,I)*SINE-X(2,I)*COSE+ZTC-HMIN                     NOV23     87
            XT(2,I)=X(3,I)*COSE+X(2,I)*SINE-YTC                          NOV23     88
            XT(1,I)=X(1,I)                                               NOV23     89
         21 CONTINUE                                                     NOV23     90
            IF(NPT1.NE.1)GO TO 52                                        NOV23     91
            GZ=XCPB(3)*SINE-XCPB(2)*COSE+ZTC-HMIN                        NOV23     92
            GY=XCPB(3)*COSE+XCPB(2)*SINE-YTC                             NOV23     93
            XCPB(3)=GZ                                                   NOV23     94
            XCPB(2)=GY                                                   NOV23     95
         52 CONTINUE                                                     NOV23     96
            SUM=NPT1                                                     NOV23     97
            DO 50 K=2,NROWS                                              NOV23     98
            SUM=SUM+IW(K-1)+1                                            NOV23     99
            IF(IW(K).NE.IW(K-1))SUM=SUM+IW(K)+1                          NOV23    100
            SUMP=SUM-IW(K)-1                                             NOV23    101
            IWK=IW(K)                                                    NOV23    102
            DO 50 I=1,IWK                                                NOV23    103
            NEL=NEL+1                                                    NOV23    104
            IN(1,NEL)=SUM+I-1                                            NOV23    105
            IN(2,NEL)=SUM+I                                              NOV23    106
            IN(3,NEL)=SUMP+I                                             NOV23    107
         50 IN(4,NEL)=SUMP+I-1                                           NOV23    108
            RETURN                                                       NOV23    109
            END                                                          NOV23    110
```

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FUNCTION RADIUS      73/73    OPT=1                    FTN 4.5+410        7~/01/17. 11.07.10       PAGE     1

                FUNCTION RADIUS(H)                                           NOV23      111
                COMMON/RAD/NBODY,R(50),Z(50)                                 NOV23      112
                PADIUS=0.0                                                   NOV23      113
                DO 10 I=1,NBODY                                              NOV23      114
                FAC=(H-Z(I))*(H-Z(I+1))                                      NOV23      115
                IF(FAC.GT.0.0)GO TO 10                                       NOV23      116
                RADIUS=R(I)+(R(I+1)-R(I))*(H-Z(I))/(Z(I+1)-Z(I))             NOV23      117
                RETURN                                                       NOV24       10
             10 CONTINUE                                                     NOV23      118
                RETURN                                                       NOV23      119
                END                                                          OGIV6        3
```

```
SUBROUTINE LISTG       73/73   OPT=1                    FTN 4.5+410        77/01/17. 11.07.10       PAGE    1

            SUBROUTINE LISTG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)            DEC06     72
            DIMENSION X(3,1),XT(3,1),IN(4,1),XCPB(1)                            LISTG      3
      C.....ARBITRARY BODY GRID SUBROUTINE                                      LISTG      4
      C.....COORDINATES OF ALL NODES MUST BE PROVIDED                           LISTG      5
      C.....NODE GROUPS COMPOSING EACH ELEMENT MUST BE INPUT                    LISTG      6
            CONVR=57.29577951                                                   LISTG      7
            NPT1=NPT+1                                                          NOV11     39
            READ(5,1000)NP,NE                                                   DEC06     73
       1000 FORMAT(4I5)                                                         LISTG      9
      C.....READ NODE POINTS AND CALCULAT XT                                    LISTG     10
            SINE=SIN(ANG/CONVR)                                                 LISTG     11
            COSE=COS(ANG/CONVR)                                                 LISTG     12
            DO 10 I=1,NP                                                        NOV11     41
            NPT=NPT+1                                                           NOV11     42
       1001 FORMAT(3F10.0,I5)                                                   DEC27     23
            READ(5,1001)X(1,NPT),X(2,NPT),X(3,NPT),NLD                          DEC27     24
            XT(1,NPT)=X(1,NPT)                                                  NOV11     44
            XT(2,NPT)=X(3,NPT)*COSE+X(2,NPT )*SINE                              NOV11     45
            XT(3,NPT)=X(3,NPT)*SINE-X(2,NPT)*COSE                               NOV11     46
            IF(NLD.GT.0)GO TO 10                                                DEC27     25
            IF(NPT1.NE.1)GO TO 10                                               NOV15    108
            IF(XT(3,I).GT.-ZTC)GO TO 10                                         NOV15    109
            YTC=XT(2,I)                                                         LISTG     20
            ZTC=-XT(3,I)                                                        NOV15    110
         10 CONTINUE                                                            LISTG     22
            DO 15 I=NPT1,NPT                                                    NOV11     47
            XT(3,I)=XT(3,I)+ZTC-HMIN                                            LISTG     25
         15 XT(2,I)=XT(2,I)-YTC                                                 LISTG     26
            IF(NPT1.NE.1)GO TO 52                                               NOV15    111
            GZ=XCPB(3)*SINE-XCPB(2)*COSE+ZTC-HMIN                               LISTG     27
            GY=XCPB(3)*COSE+XCPB(2)*SINE-YTC                                    LISTG     28
            XCPB(3)=GZ                                                          LISTG     29
            XCPB(2)=GY                                                          LISTG     30
         52 CONTINUE                                                            NOV15    112
      C.....READ IN ELEMENTS                                                    LISTG     31
            DO 20 I=1,NE                                                        NOV11     48
            NEL=NEL+1                                                           NOV11     49
         20 READ(5,1000)IN(1,NEL),IN(2,NEL),IN(3,NEL),IN(4,NEL)                 NOV11     50
            RETURN                                                              LISTG     34
            END                                                                 LISTG     35

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

   30       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   36       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   31       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   31       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   32       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   33       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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SUBROUTINE GRID        73/73    OPT=I                          FTN 4.5+410        77/01/17. 11.07.10        PAGE    1

            SUBROUTINE GRID(NPT,NEL,X,XT,IN,PHIO,XC,ACHECK,NNLD)                    DEC14      11
            DIMENSION X(3,1),XT(3,1),IN(4,1),XC(3,1),PHIO(2,1)                      GRID        3
      C.....PRINT NODES                                                             GRID        4
            WRITE(6,2006)                                                           GRID        5
       2006 FORMAT(1H0,13X,5HNODE ,10X,1HX,8X,1HY,8X,1HZ,9X,2HXP,8X,2HYP,8X,        GRID        6
           *2HZP)                                                                   GRID        7
            DO 5 I=1,NPT                                                            GRID        8
          5 WRITE(6,2007)I,(X(J,I),J=1,3),(XT(J,I),J=1,3)                           GRID        9
       2007 FORMAT(1H ,10X,I5,5X,6(2X,F8.4))                                        GRID       10
            WRITE(6,2008)                                                           GRID       11
       2008 FORMAT(1H0,15X,7HELEMENT,7X,1H1,9X,1H2,9X,1H3,9X,1H4,7X,2HXC,7X,        NOV03      26
           *2HYC,7X,2HZC,7X,2HRC,8X,2HTC,7X,4HAREA/1H )                             NOV03      27
            CALL CENT(X,XC,IN,NEL,PHIO)                                             GRID       13
      C.....PRINT ELEMENT NODES,AREA,AND CENTROIDS                                  GRID       14
            ACHECK=0.0                                                              NOV15     114
            DO 10 I=1,NEL                                                           GRID       15
            IF(I.EQ.NNLD)WRITE(6,2010)                                              DEC14      12
            ACHECK=ACHECK+PHIO(2,I)                                                 NOV15     115
            R=SQRT(XC(1,I)**2+XC(2,I)**2)                                           NOV03      28
            ANGLE=57.2957795*ATAN2(XC(1,I),XC(2,I))                                 NOV02       4
         10 WRITE(6,2009)I,(IN(J,I),J=1,4),(XC(J,I),J=1,3),R,ANGLE,PHIO(2,I)        NOV03      29
       2009 FORMAT(1H ,10X,5(5X,I5),4(2X,F8.5),2X,F8.3,E12.4)                       NOV03      30
            ACHECK=SQRT(ACHECK/FLOAT(NEL))/1000.                                    NOV15     116
            RETURN                                                                  GRID       20
       2010 FORMAT(1H0,30X,*NO LOAD ELEMENTS*)                                      DEC14      13
            END                                                                     GRID       21
```

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SUBROUTINE ADVN        73/73   OPT=1                         FTN 4.5+410        77/01/17. 11.07.10        PAGE    1

 1             SUBROUTINE ADVN(XT,VEZ,VEY,VEX,CWT,WX,ANG,XCPB,IS,NPT,DT,              ADVN      2
              *DDZ,HMAX)                                                              ADVN      3
         C.....SUBROUTINE MOVES NODES FORWARD IN TIME                                 ADVN      4
         C.....THE SPLASH HEIGHT,DELTA H*(CWT(I)-1.) IS BASED ON THE DELTA            ADVN      5
 5       C     H OF THE DEEPEST POINT.                                                ADVN      6
               DIMENSION XT(3,1),VEZ(1),VEY(1),VEX(1),CWT(1),WX(1),XCPB(1),DT(1)      ADVN      7
               CONVR=57.29577951                                                      NOV03    31
               DDT=DT(IS)                                                             ADVN      8
               CW=CWT(IS)                                                             ADVN      9
10             VSX=VEX(IS)                                                            ADVN     11
               VSY=VEY(IS)                                                            ADVN     12
               VSZ=VEZ(IS)                                                            ADVN     13
               ZDEEP=1000.                                                            NOV05     6
               DG=WX(IS)*DDT                                                          NOV03    32
15             ANG=ANG+DG                                                             NOV03    33
               SIND=SIN(DG/CONVR)                                                     NOV03    34
               COSD=COS(DG/CONVR)                                                     NOV03    35
               DO 10 I=1,NPT                                                          ADVN     15
               ZP=XT(3,I)-XCPB(3)                                                     NOV03    37
20             YP=XT(2,I)-XCPB(2)                                                     NOV03    38
               DZ=DDT*VSZ-ZP*(1.-COSD)+YP*SIND                                        NOV05     7
               XT(3,I)=XT(3,I)+DZ                                                     NOV03    40
               ZCH=XT(3,I)                                                            ADVN     17
               XT(2,I)=XT(2,I)+VSY*DDT-YP*(1.-COSD)-ZP*SIND                           NOV08     5
25             XT(1,I)=XT(1,I)+DDT*VSX                                                ADVN     20
               IF(ZCH.GT.ZDEEP)GO TO 10                                               ADVN     21
               ZDEEP=ZCH                                                              ADVN     22
               DDZ=DZ*(1.-CW)                                                         NOV03    42
               HMAX=DDZ-XT(3,I)                                                       NOV05     9
30          10 CONTINUE                                                               ADVN     25
               DO 15 I=1,NPT                                                          ADVN     26
               XT(3,I)=XT(3,I)-DDZ                                                    NOV03    44
            15 CONTINUE                                                               NOV05    10
               XCPB(3)=XCPB(3)+VSZ*DDT-DDZ                                            NOV03    47
35             XCPB(2)=XCPB(2)+VSY*DDT                                                ADVN     29
               XCPB(1)=XCPB(1)+VSX*DDT                                                ADVN     30
               RETURN                                                                 ADVN     31
               END                                                                    ADVN     32
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
19	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
20	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
34	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
34	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
35	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
35	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.

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SUBROUTINE CREL       73/73    OPT=1                     FTN 4.5+410        77/01/17. 11.07.10        PAGE     1

           SUBROUTINE CREL(X,IN,IT,IG,IM,IEM,NPT,NEL-ANG,INP,XT,XCPB,CGL,    NOV15     117
          *ACHECK)                                                           NOV15     118
           DIMENSION X(3,1),IN(4,1),IT(4,1),IQ(1),IM(1),I(4),XT(3,1),XCPB(3) JAN01       6
           CONVR=57.29577951                                                 NOV03      50
           IEM=0                                                             CREL        7
           INP=NPT                                                           CREL        8
           DO 5 K=1,NEL                                                      CREL        9
           ITOT=0                                                            CREL       10
           ITOTC=0                                                           DEC12       2
           SUM=X(1,IN(1,K))+X(1,IN(2 ,K))+X(1,IN(3,K))+X(1,IN(4,K))          NOV11      51
     C.....COUNT NUMBER OF POINT BELOW SURFACE                               NOV11      52
           DO 10 J=1,4                                                       CREL       11
           I(J)=0                                                            CREL       12
           II=IN(J,K)                                                        CREL       13
           IF(XT(3,II).GT.0.0)I(J)=1                                         DEC12       3
           IF(XT(3,II).GT.-ACHECK)ITOTC=ITOTC+1                              DEC12       4
           IF(I(J).EQ.0)IF=J                                                 CREL       15
           IF(I(J).EQ.1)JF=J                                                 CREL       16
        10 ITOT=ITOT+I(J)                                                    CREL       17
     C.....IF ALL POINTS ARE ABOVE WATER SURFACE DISCARD ELEMENT.            NOV11      53
           IF(ITOT.EQ.4)GO TO 5                                              CREL       18
           IF(ITOTC.EQ.4)GO TO 5                                             DEC12       5
           IEM=IEM+1                                                         CREL       19
           IM(IEM)=0                                                         CREL       20
           IQ(IEM)=K                                                         CREL       21
           DO 15 L=1,4                                                       CREL       22
        15 IT(L,IEM)=IN(L,K)                                                 CREL       23
     C.....IF ALL POINTS ARE BELOW THE WATER USE ELEMENTS AS IS.             NOV11      54
           IF(ITOT.EQ.0)GO TO 5                                              CREL       24
           IM(IEM)=1                                                         CREL       25
     C.....DETERMINE NODES BOUNDING ELEMENT SIDES INTERSECTED BY THE SURFACE. NOV11     55
           DO 25 L=1,4                                                       CREL       26
           LM=L+1                                                            CREL       27
           IF(L.EQ.4)LM=1                                                    CREL       28
           IF(I(L)+I(LM).NE.1)GO TO 25                                       CREL       29
           IG=L                                                              CREL       30
           IB=LM                                                             CREL       31
           IF(I(L).EQ.0 )GO TO 30                                            CREL       32
           IG=LM                                                             CREL       33
           IB=L                                                              CREL       34
        30 IIG=IN(IG,K)                                                      CREL       35
           IIB=IN(IB,K)                                                      CREL       36
           INP=INP+1                                                         CREL       37
           XT(3,INP)=0.0                                                     CREL       38
           RATIO=-XT(3,IIG)/(XT(3,IIB)-XT(3,IIG))                            CREL       39
           XT(2,INP)=XT(2,IIG)+RATIO*(XT(2,IIB)-XT(2,IIG))                   CREL       40
           XT(1,INP)=XT(1,IIG)+RATIO*(XT(1,IIB)-XT(1,IIG))                   CREL       41
           IT(IB,IEM)=INP                                                    CREL       42
        25 CONTINUE                                                          CREL       43
     C.....IF TWO NODES ARE SUBMERGED NEW ELEMENT COMPLETE.                  NOV11      56
           IF(ITOT.EQ.2)GO TO 5                                              CREL       44
           IF(ITOT.EQ.1)GO TO 6                                              CREL       45
     C.....ONLY ONE NODE SUBMERGED                                           NOV11      57
           IP1= IF+1                                                         CREL       46
           IP2=IF-1                                                          CREL       47
           IF(IP1.EQ.5)IP1=1                                                 CREL       48
           IF(IP2.EQ.0)IP2=4                                                 CREL       49
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SUBROUTINE CREL        73/73    OPT=1                          FTN 4.5+410         77/01/17. 11.07.18        PAGE     2

                 M1=IT(IP1,IEM)                                                CREL        50
                 M2=IT(IP2,IEM)                                                CREL        51
                 INP=INP+1                                                     CREL        52
                 DO 9 JS=1,3                                                   CREL        53
                 XT(JS,INP)=(XT(JS,M1)+XT(JS,M2))/2.                           CREL        54
               9 CONTINUE                                                      CREL        55
                 IP3=IP1+1                                                     CREL        56
                 IF(IP3.EQ.5)IP3=1                                             CREL        57
                 IT(IP3,IEM)=INP                                               CREL        58
                 GO TO 5                                                       CREL        59
           C.....THREE SUBMERGED POINTS                                        NOV11       58
               6 JF1=JF+1                                                      CREL        60
                 IF(JF1.EQ.5)JF1=1                                             CREL        61
                 JF2=JF1+1                                                     CREL        62
                 IF(JF2.EQ.5)JF2=1                                             CREL        63
                 JF3=JF2+1                                                     CREL        64
                 IF(JF3.EQ.5)JF3=1                                             CREL        65
                 IF(SUM.LT.0.0)GO TO 45                                        NOV11       59
                 IT(JF,IEM)=INP-1                                              CREL        66
                 IT(JF1,IEM)=INP+1                                             CREL        67
                 IEM=IEM+1                                                     CREL        68
                 IT(JF,IEM)=INP                                                CREL        69
                 IT(JF1,IEM)=IN(JF1,K)                                         CREL        70
                 IT(JF2,IEM)=INP+1                                             CREL        71
                 IT(JF3,IEM)=INP-1                                             CREL        72
                 IP1=IN(JF1,K)                                                 CREL        73
                 IP2=IN(JF2,K)                                                 CREL        74
                 GO TO 50                                                      NOV11       60
              45 IT(JF,IEM)=INP                                                NOV11       61
                 IT(JF3,IEM)=INP+1                                             NOV11       62
                 IEM=IEM+1                                                     NOV11       63
                 IT(JF,IEM)=INP                                                NOV11       64
                 IT(JF1,IEM)=INP+1                                             NOV11       65
                 IT(JF2,IEM)=IN(JF3,K)                                         NOV11       66
                 IT(JF3,IEM)=INP-1                                             NOV11       67
                 IP1=IN(JF2,K)                                                 NOV11       68
                 IP2=IN(JF3,K)                                                 NOV11       69
              50 CONTINUE                                                      NOV11       70
                 INP=INP+1                                                     CREL        75
                 IQ(IEM)=K                                                     CREL        76
                 IM(IEM)=2                                                     CREL        77
                 DO 8 LK=1,3                                                   CREL        78
                 XT(LK,INP)=(XT(LK,IP1)+XT(LK,IP2))/2.                         CREL        79
               8 CONTINUE                                                      CREL        80
                 IF(JF.NE.1)GO TO 5                                            CREL        81
                 DO 41 JGG=1,3                                                 CREL        82
                 XLK=XT(JGG,INP-1)                                             CREL        83
                 XT(JGG,INP-1)=XT(JGG,INP-2)                                   CREL        84
              41 XT(JGG,INP-2)=XLK                                             CREL        85
               5 CONTINUE                                                      CREL        86
           C.....TRANSFORM GENERATED NODES TO WATER COORDINATES.               NOV11       71
                 IF(NPT.EQ.INP)RETURN                                          DEC15        3
                 SINE=SIN(ANG/CONVR)                                           CREL        87
                 COSE=COS(ANG/CONVR)                                           CREL        88
                 NPT1=NPT+1                                                    CREL        89
                 DO 20 K=NPT1,INP                                              CREL        90
                 ZPT=XT(3,K)-XCPB(3)                                           NOV03       51
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SUBROUTINE CREL        73/73    OPT=1                          FTN 4.5+410      77/01/17. 11.07.10      PAGE     3

              YPT=XT(2,K)-XCPB(2)                                           NOV03      52
              X(3,K)=ZPT*SINE+YPT*COSE+CGL                                  NOV02      11
              X(2,K)=-ZPT*COSE+YPT*SINE                                     CREL       94
           20 X(1,K)=XT(1,K)                                                CREL       95
              RETURN                                                        CREL       96
              END                                                           CREL       97
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SUBROUTINE MAN        73/73    OPT=1                         FTN 4.5+410        77/01/17. 11.37.10        PAGE     1

          SUBROUTINE MAN(X,IT,XT,XC,XCP,IEM,ANG,PHIO,IO,XCPB,CGL,E)          NOV05      11
          DIMENSIONX(3,1),IT(4,1),XT(3,1),XC(3,1),XCP(3,1),E(3,3,1),F(3)     MAN         3
         1,G(3),XCPB(3),PHIO(2,1),IQ(1)                                      MAN         4
          CONVR=57.29577951                                                  MAN         5
          SINE=SIN(ANG/CONVR)                                                MAN         6
          COSE=COS(ANG/CONVR)                                                MAN         7
          CALL CENT(XT,XCP,IT,IEM,PHIO)                                      NOV03      54
          DO 10 K=1,IEM                                                      MAN         9
          I1=IT(1,K)                                                         MAN        10
          I2=IT(2,K)                                                         MAN        11
          I3=IT(3,K)                                                         MAN        12
          I4=IT(4,K)                                                         MAN        13
    C.....TRANSFORM CENTROID TO BODY COORDINATES                             MAN        14
          ZPT=XCP(3,K)-XCPB(3)                                               MAN        15
          YPT=XCP(2,K)-XCPB(2)                                               MAN        16
          XC(1,K)=XCP(1,K)                                                   MAN        17
          XC(2,K)=-ZPT*COSE+YPT*SINE                                         MAN        18
          XC(3,K)=ZPT*SINE+YPT*COSE+CGL                                      MAN        19
          DO 20 L=1,3                                                        MAN        20
          F(L)=XT(L,I3)-XT(L,I1)                                             MAN        21
       20 G(L)=XT(L,I2)-XT(L,I4)                                             MAN        22
          DEL1=SQRT(F(1)*F(1)+F(2)*F(2)+F(3)*F(3))                           MAN        23
          DEL2=SQRT(G(1)*G(1)+G(2)*G(2)+G(3)*G(3))                           MAN        24
          DO 25 L=1,3                                                        MAN        25
          E(L,1,K)=F(L)/DEL1                                                 MAN        26
       25 E(L,2,K)=G(L)/DEL2                                                 MAN        27
          F(1)=E(2,1,K)*E(3,2,K)-E(3,1,K)*E(2,2,K)                           MAN        28
          F(2)=E(3,1,K)*E(1,2,K)-E(1,1,K)*E(3,2,K)                           MAN        29
          F(3)=E(1,1,K)*E(2,2,K)-E(1,2,K)*E(2,1,K)                           MAN        30
          DEL=SQRT(F(1)*F(1)+F(2)*F(2)+F(3)*F(3))                            MAN        31
          DO 30 LI=1,3                                                       MAN        32
       30 E(LI,3,K)=F(LI)/DEL                                                MAN        33
          E(1,2,K)=E(2,3,K)*E(3,1,K)-E(2,1,K)*E(3,3,K)                       MAN        34
          E(2,2,K)=E(1,1,K)*E(3,3,K)-E(1,3,K)*E(3,1,K)                       MAN        35
          E(3,2,K)=E(1,3,K)*E(2,1,K)-E(1,1,K)*E(2,3,K)                       MAN        36
       10 CONTINUE                                                           MAN        37
          RETURN                                                             MAN        38
          END                                                                MAN        39
```

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SUBROUTINE ELEMST     73/73   OPT=1                    FTN 4.5+410        77/01/17. 11.07.10        PAGE     1

            SUBROUTINE ELEMST(INP,NPT,IT,IEM,IQ,IM,X,XT,XC,XCP,E,PHIO,ISTEP,H) ELEMST      2
            DIMENSION X(3,1),XT(3,1),IT(4,1),PHIO(2,1),XC(3,1),XCP(3,1),      ELEMST      3
           *IQ(1),IM(1),E(3,3,1)                                               ELEMST      4
            WRITE(6,2030)ISTEP,H                                               ELEMST      5
       2030 FORMAT(1H1,30X,5HSTEP ,I5,2X,6HDEPTH ,F10.7)                       ELEMST      6
       2010 FORMAT(1H0,10X,15HGENERATED NODES)                                 ELEMST      7
            NPT1=NPT+1                                                         ELEMST      8
            WRITE(6,2010)                                                      NOV03      55
            WRITE(6,2006)                                                      ELEMST      9
            DO 25 I=NPT1,INP                                                   ELEMST     10
         25 WRITE(6,2007)I,(X(J,I),J=1,3),(XT(J,I),J=1,3)                      ELEMST     11
            WRITE(6,2011)                                                      ELEMST     12
            WRITE(6,2008)                                                      ELEMST     13
       2011 FORMAT(1H0,10X,12HRUN ELEMENTS)                                    ELEMST     14
            DO 30 I=1,IEM                                                      ELEMST     15
         30 WRITE(6,2009)I,(IT(J,I),J=1,4)                                     ELEMST     16
            WRITE(6,2019)                                                      ELEMST     17
       2019 FORMAT(1H1,15X,18HELEMENT STATISTICS)                              ELEMST     18
            DO 35 I=1,IEM                                                      ELEMST     19
            IF(PHIO(1,IQ(I)).GT.0.0)GO TO 35                                   ELEMST     20
            IF(IM(I).EQ.0)PHIO(1,IQ(I))=1.                                     ELEMST     21
            WRITE(6,2012)I,IQ(I),IM(I),(XC(J,I),J=1,3),(XCP(JR,I),JR=1,3)      ELEMST     22
       2012 FORMAT(1H0,12HELEMENT NO. ,I5,5X,14HREFERENCE NO. ,I5,5X,          ELEMST     23
           218HMODIFICATION CODE ,I5/1H ,10X,12HCENTROIDE X ,3(F8.4,2X),2HXP,  ELEMST     24
           33(2X,F8.4))                                                        ELEMST     25
            WRITE(6,2013)                                                      ELEMST     26
       2013 FORMAT(1H0,5X,6HCORNER,7X,4HNODE,9X,1HX,9X,1HY,9X,1HZ,9X,2HXP,     ELEMST     27
           29X,2HYP,8X,2HZP)                                                   ELEMST     28
            DO 45 K=1,4                                                        ELEMST     29
            I1=IT(K,I)                                                         ELEMST     30
         45 WRITE(6,2016)K,I1,(X(K1,I1),K1=1,3),(XT(K2,I1),K2=1,3)             ELEMST     31
       2016 FORMAT(1H ,5X,2(I5,5X),6(F8.4,2X))                                 ELEMST     32
            WRITE(6,2017)PHIO(2,I)                                             ELEMST     33
       2017 FORMAT(1H0,5X,6HVECTOR,8X,1H1,8X,1H2,9X,1H3,20X,7HAREA = ,F12.7)   ELEMST     34
            DO 50 K=1,3                                                        ELEMST     35
         50 WRITE(6,2018)K,(E(JR,K,I),JR=1,3)                                  ELEMST     36
       2018 FORMAT(1H ,8X,I5,3(2X,F8.4))                                       ELEMST     37
         35 CONTINUE                                                           ELEMST     38
            RETURN                                                             ELEMST     40
       2006 FORMAT(1H0,13X,5HNODE ,10X,1HX,8X,1HY,8X,1HZ,9X,2HXP,8X,2HYP,8X,   NOV03      56
           *2HZP)                                                              ELEMST     42
       2007 FORMAT(1H ,10X,I5,5X,6(2X,F8.4))                                   ELEMST     43
       2008 FORMAT(1H0,15X,7HELEMENT,9X,1H1,9X,1H2,9X,1H3,9X,1H4/1H )          ELEMST     44
       2009 FORMAT(1H ,10X,5(5X,I5),4(2X,F8.5),2X,F8.3)                        ELEMST     45
            END                                                                ELEMST     46
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SUBROUTINE VNORM      73/73   OPT=1                    FTN 4.5+410      77/01/17. 11.07.16      PAGE     1

  1              SUBROUTINE VNORM(VEZ,VEY,VEX,WX,VNO,E,IEM,ISTEP,XCP,XCPB,IPRINT)   NOV08     12
                 DIMENSION VEZ(1),VEY(1),VEX(1),WX(1),VNO(1),E(3,3,1),XCP(3,1),     VNORM      3
                *XCPB(1)                                                            VNORM      4
                 CONVR=57.29577951                                                  NOV08     13
  5              VZ=(VEZ(ISTEP)+VEZ(ISTEP+1))/2.                                    VNORM      5
                 VY=(VEY(ISTEP)+VEY(ISTEP+1))/2.                                    VNORM      6
                 VX=(VEX(ISTEP)+VEX(ISTEP+1))/2.                                    VNORM      7
                 WXX=(WX(ISTEP)+WX(ISTEP+1))/2.                                     VNORM      8
                 IF(IPRINT.EQ.1)WRITE(6,2000)VX,VY,VZ,WXX                           NOV08     14
 10              DO 5 I=1,IEM                                                       VNORM      9
                 VZC=VZ+WXX*(XCP(2,I)-XCPB(2))/CONVR                                NOV08     15
                 VYC=VY-WXX*(XCP(3,I)-XCPB(3))/CONVR                                NOV08     16
               5 VNO(I)=VZC*E(3,3,I)+VYC*E(2,3,I)+VX*E(1,3,I)                       NOV05     12
                 RETURN                                                             VNORM     13
 15         2000 FORMAT(1H1,10X,*VX = *,F10.3,*  VY = *,F10.3,*  VZ = *,F10.3,      NOV08     17
                **  WX = *,F10.2)                                                   NOV08     18
                 END                                                                VNORM     14

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

     11     I      XCPB       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     12     I      XCPB       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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      SUBROUTINE AMAT(XCP,XT,IT,IEM,A,AY,AX,PHI,VNO,F,IPHI)              NOV09     2
      DIMENSION XCP(3,1),XT(3,1),PHI(1),VNO(1),A(1),AX(1),AY(1),         AMAT      3
     *IT(4,1),E(3,3,1)                                                   AMAT      4
      DIMENSION F(3),XI(3,4),XP(3),C(4),D(4),CS(4),Q(4),CR(4),R(4),      AMAT      5
     2S(2,4),XJ(4),V(3),VI(3),X(3)                                       AMAT      6
      DIMENSION XCPI(3),EI(3,3),XTI(3,4)                                 AMAT      7
      PIE=3.14159265                                                     AMAT      8
      IXXN=3-IPHI                                                        NOV09     3
      IPHC=2-IPHI                                                        NOV09     4
      CONVR=180./PIE                                                     AMAT      9
      DO 5 J=1,IEM                                                       AMAT     10
      DO 2 I=1,IEM                                                       AMAT     11
    2 A(I)=AX(I)=AY(I)=PHI(I)=0.0                                        AMAT     12
      DO 41 I=1,3                                                        AMAT     13
      XCPI(I)=XCP(I,J)                                                   AMAT     14
      DO 42 K=1,3                                                        AMAT     15
   42 EI(K,I)=E(K,I,J)                                                   AMAT     16
      DO 41 L=1,4                                                        AMAT     17
   41 XTI(I,L)=XT(I,IT(L,J))                                             AMAT     18
      DO 6 IX=1,IXXN                                                     NOV09     5
      DO 7 IZ=1,2                                                        AMAT     20
C.....CALCULATE NODE LOCATION IN ELEMENT COORDINATES                      AMAT     21
      DO 11 L=1,4                                                        AMAT     22
      DO 10 K=1,3                                                        AMAT     23
   10 F(K)=XTI(K,L)-XCPI(K)                                              AMAT     24
      DO 11 IR=1,3                                                       AMAT     25
   11 XI(IR,L)=F(1)*EI(1,IR)+F(2)*EI(2,IR)+F(3)*EI(3,IR)                 AMAT     26
      DSI=XI(1,3)-XI(1,1)                                                AMAT     27
      DNU=XI(2,3)-XI(2,1)                                                AMAT     28
      DSN=XI(2,2)-XI(2,4)                                                AMAT     29
      XI00=DSI*DSN*.5                                                    AMAT     30
      DCM2=DSI*DSI+DNU*DNU                                               AMAT     31
      HLTI=(XI(1,2)-XI(1,4))**2+DSN*DSN                                  AMAT     32
      IF(DCM2.LT.HLTI)DCM2=HLTI                                          AMAT     33
      C1=XI(1,1)+XI(1,2)+XI(1,3)                                         NOV09     6
      C2=XI(1,1)*(XI(1,1)+XI(1,3))+XI(1,3)*XI(1,3)                       NOV09     7
      C3=XI(1,4)+C1                                                      NOV09     8
      C4=C3-XI(1,2)                                                      NOV09     9
      XI20=DSI/12.*(XI(2,1)*(XI(1,4)-XI(1,2))*C3+C2*(XI(2,2)-XI(2,4))    NOV09    10
     *+XI(1,2)*XI(2,2)*C1-XI(1,4)*XI(2,4)*C4)                            NOV09    11
      C1=(XI(2,1)-XI(2,4))*(XI(2,1)+XI(2,4))                             NOV09    12
      C2=(XI(2,1)-XI(2,2))*(XI(2,1)+XI(2,2))                             NOV09    13
      C3=2.*XI(2,1)+XI(2,2)+XI(2,4)                                      NOV09    14
      XI11=DSI/24.*(2.*XI(1,4)*C1-2.*XI(1,2)*C2+(XI(1,1)+XI(1,3))*       NOV09    15
     1DSN*C3)                                                            NOV09    16
      C2=XI(2,2)+XI(2,4)                                                 NOV09    17
      C1=(XI(2,1)+C2)**2                                                 NOV09    18
      XI02=XI00/6.*(C1-XI(2,1)*C2-XI(2,2)*XI(2,4))                       NOV09    19
      DO 27 K=1,4                                                        AMAT     34
      K1=K+1                                                             AMAT     35
      IF(K.EQ.4)K1=1                                                     AMAT     36
      D(K)=SQRT((XI(1,K1)-XI(1,K))**2+(XI(2,K1)-XI(2,K))**2)             AMAT     37
      C(K)=(XI(1,K1)-XI(1,K))/D(K)                                       AMAT     38
   27 CS(K)=(XI(2,K1)-XI(2,K))/D(K)                                      AMAT     39
      DO 45 I=1,IEM                                                      AMAT     40
C.....DETERMINE POINT AT WHICH VELOCITY IS INDUCED IN ELEMENT COORDINATE AMAT     41
      DO 15 K=1,3                                                        AMAT     42
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SUBROUTINE AMAT       73/73   OPT=1                     FTN 4.5+410       77/01/17. 11.07.10       PAGE     2

         15 X(K)=XCP(K,I)-XCPI(K)                                          AMAT      43
            R02=X(1)*X(1)+X(2)*X(2)+X(3)*X(3)                              AMAT      44
            IF(R02/DCM2.LE.16.)GO TO 70                                    AMAT      45
            DO 21 K=1,3                                                    AMAT      46
         21 XP(K)=X(1)*E(1,K,I)+X(2)*E(2,K,I)+X(3)*E(3,K,I)                AMAT      47
            R0=SQRT(R02)                                                   AMAT      48
            PH=XI00/R0                                                     AMAT      49
            FAC=PH/R02                                                     AMAT      50
            VI(1)=XP(1)*FAC                                                AMAT      51
            VI(2)=XP(2)*FAC                                                AMAT      52
            VI(3)=XP(3)*FAC                                                AMAT      53
            GO TO 71                                                       AMAT      54
         70 CONTINUE                                                       AMAT      55
            DO 20 K=1,3                                                    AMAT      56
         20 XP(K)=X(1)*EI(1,K)+X(2)*EI(2,K)+X(3)*EI(3,K)                   AMAT      57
      C.....CALCULATE INDUCED VELOCITIES                                   AMAT      58
            IF(R02/DCM2.LE.6)GO TO 72                                      NOV09     20
      C.....MULTIPOLE EXPANSION                                            NOV09     21
            R02=1./R02                                                     NOV09     22
            R01=SQRT(R02)                                                  NOV09     23
            R03=R01*R02                                                    NOV09     24
            R05=R02*R03                                                    NOV09     25
            R07=R05*R02                                                    NOV09     26
            XX=XP(1)                                                       NOV09     27
            YY=XP(2)                                                       NOV09     28
            ZZ=XP(3)                                                       NOV09     29
            XX2=XX*XX                                                      NOV09     30
            YY2=YY*YY                                                      NOV09     31
            ZZ2=ZZ*ZZ                                                      NOV09     32
            PP=YY2+ZZ2-4.*XX2                                              NOV09     33
            QQ=XX2+ZZ2-4.*YY2                                              NOV09     34
            WX=-XX*R03                                                     NOV09     35
            WY=-YY*R03                                                     NOV09     36
            WZ=-ZZ*R03                                                     NOV09     37
            WXX=-(PP+2.*XX2)*R05                                           NOV09     38
            WXY=3.*XX*YY*R05                                               NOV09     39
            WYY=-(QQ+2.*YY2)*R05                                           NOV09     40
            WXXX=3.*XX*(3.*PP+10.*XX2)*R07                                 NOV09     41
            WXXY=3.*YY*PP*R07                                              NOV09     42
            WXYY=3.*XX*QQ*R07                                              NOV09     43
            WYYY=3.*YY*(3.*QQ+10.*YY2)*R07                                 NOV09     44
            WXXZ=3.*ZZ*PP*R07                                              NOV09     45
            WXYZ=-15.*XX*YY*ZZ*R07                                         NOV09     46
            WYYZ=3.*ZZ*QQ*R07                                              NOV09     47
            PH=XI00*R01+.5*(XI20*WXX+2.*XI11*WXY+XI02*WYY)                 NOV09     48
            V(1)=-XI00*WX-.5*(XI20*WXXX+2.*XI11*WXXY+XI02*WXYY)            NOV09     49
            V(2)=-XI00*WY-.5*(XI20*WXXY+2.*XI11*WXYY+XI02*WYYY)            NOV09     50
            V(3)=-XI00*WZ-.5*(XI20*WXXZ+2.*XI11*WXYZ+XI02*WYYZ)            NOV09     51
            GO TO 73                                                       NOV09     52
         72 CONTINUE                                                       NOV09     53
      C.....COMPLETE FORMULAS                                              NOV09     54
            DO 25 K=1,4                                                    AMAT      59
            K1=K+1                                                         AMAT      60
            IF(K.EQ.4)K1=1                                                 AMAT      61
            S(1,K)=(XI(1,K)-XP(1))*C(K)+(XI(2,K)-XP(2))*CS(K)              AMAT      62
            S(2,K)=(XI(1,K1)-XP(1))*C(K)+(XI(2,K1)-XP(2))*CS(K)            AMAT      63
            CR(K)=(XP(1)-XI(1,K))*CS(K)-(XP(2)-XI(2,K))*C(K)               AMAT      64
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      R(K)=SQRT((XP(1)-XI(1,K))**2+(XP(2)-XI(2,K))**2+XP(3)**2)        AMAT   65
   25 CONTINUE                                                          AMAT   66
      V(1)=0.0                                                          AMAT   67
      V(2)=0.0                                                          AMAT   68
      V(3)=0.0                                                          AMAT   69
      AZ=ABS(XP(3))                                                     AMAT   70
      AS=-1.                                                            AMAT   71
      IF(XP(3).GE.0.0)AS=1.                                             AMAT   72
      PH=0.5                                                            AMAT   73
      DO 30 K=1,4                                                       AMAT   74
      K1=K+1                                                            AMAT   75
      IF(K.EQ.4)K1=1                                                    AMAT   76
      Q(K)=ALOG((R(K)+R(K1)+D(K))/(R(K)+R(K1)-D(K)))                    AMAT   77
      XJ(K)=0.0                                                         AMAT   78
      IF(CR(K).EQ.0.0)GO TO 61                                          AMAT   79
      FT=ABS(XP(3)/CR(K))                                               AMAT   80
      XJ(K)=ABS(CR(K))/CR(K)*(ATAN(FT*S(2,K)/R(K1))-ATAN(FT*S(1,K)/     AMAT   81
     2R(K)))                                                            AMAT   82
   61 CONTINUE                                                          AMAT   83
      PH=PH+AZ*XJ(K)+CR(K)*Q(K)                                         AMAT   84
      V(1)=V(1)-CS(K)*Q(K)                                              AMAT   85
      V(2)=V(2)+C(K)*Q(K)                                               AMAT   86
   30 V(3)=V(3)-XJ(K)                                                   AMAT   87
      DTH=2.*PIE                                                        AMAT   88
      ICRT=0                                                            AMAT   89
      DO 46 KU=1,4                                                      AMAT   90
      IF(CR(KU).GT.0.0)ICRT=1+ICRT                                      AMAT   91
   46 CONTINUE                                                          AMAT   92
      IF(ICRT.LT.4)DTH=0.0                                              AMAT   93
      PH=PH-AZ*DTH                                                      AMAT   94
      V(3)=AS*(V(3)+DTH)                                                AMAT   95
C.....TRANSFORM VELOCITY TO COORDINATE OF ELEMENT AT WHICH IT IS INDUCED AMAT   96
   73 CONTINUE                                                          NOV09  55
      VI(1)=0.0                                                         AMAT   97
      VI(2)=0.0                                                         AMAT   98
      VI(3)=0.0                                                         AMAT   99
      DO 35 K=1,3                                                       AMAT  100
      DO 35 L=1,3                                                       AMAT  101
   35 VI(K)=VI(K)+V(L)*(EI(1,L)*E(1,K,I)+EI(2,L)*E(2,K,I)+EI(3,L)*      AMAT  102
     2E(3,K,I))                                                         AMAT  103
   71 CONTINUE                                                          AMAT  104
      BLK=-(-1.)**IZ                                                    AMAT  105
      A(I)=A(I)+VI(3)*BLK                                               AMAT  106
      AY(I)=AY(I)+VI(2)*BLK                                             AMAT  107
      AX(I)=AX(I)+VI(1)*BLK                                             AMAT  108
      PHI(I)=PHI(I)+PH*BLK                                              AMAT  109
   45 CONTINUE                                                          AMAT  110
      XCPI(3)=-XCPI(3)                                                  AMAT  111
      DO 8 IU=1,4                                                       AMAT  112
    8 XTI(3,IU)=-XTI(3,IU)                                              AMAT  113
      EI(3,1)=-EI(3,1)                                                  AMAT  114
      EI(1,2)=-EI(1,2)                                                  AMAT  115
      EI(2,2)=-EI(2,2)                                                  AMAT  116
      EI(3,3)=-EI(3,3)                                                  AMAT  117
      DO 22 IU=1,3                                                      AMAT  118
      XBLAK=XTI(IU,2)                                                   AMAT  119
      XTI(IU,2)=XTI(IU,4)                                               AMAT  120
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SUBROUTINE AMAT       73/73   OPT=1                          FTN 4.5+410       77/01/17. 11.07.10       PAGE     4

            22 XTI(IU,4)=XBLAK                                                AMAT       121
             7 CONTINUE                                                       AMAT       122
               IF(IPHC)4,6                                                    NOV09       56
             4 CONTINUE                                                       NOV09       57
               XCPI(1)=-XCPI(1)                                               AMAT.      123
               DO 9 IU=1,4                                                    AMAT       124
             9 XTI(1,IU)=-XTI(1,IU)                                           AMAT       125
               EI(1,1)=-EI(1,1)                                               AMAT       126
               EI(2,2)=-EI(2,2)                                               AMAT       127
               EI(3,2)=-EI(3,2)                                               AMAT       128
               EI(1,3)=-EI(1,3)                                               AMAT       129
               DO 23 IU=1,3                                                   AMAT       130
               XBLAK=XTI(IU,2)                                                AMAT       131
               XTI(IU,2)=XTI(IU,4)                                            AMAT       132
            23 XTI(IU,4)=XBLAK                                                AMAT       133
             6 CONTINUE                                                       AMAT       134
               WRITE(16)(A(K),K=1,IEM),(AX(K),K=1,IEM),(AY(K),K=1,IEM),       AMAT       135
              2(PHI(K),K=1,IEM)                                               AMAT       136
             5 CONTINUE                                                       AMAT       137
               REWIND 16                                                      AMAT       138
               RETURN                                                         AMAT       139
               END                                                            AMAT       140
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SUBROUTINE OUTPUT     73/73    OPT=1                    FTN 4.5+410        77/01/17. 11.07.10       PAGE

          SUBROUTINE OUTPUT(IEM,IT,IN,ANG,SIG,VNO,AN,ANS,AX,AXS,            NOV03      58
         *AY,AYS,PHI,PHIS,PHIO,XC,XCP,IQ,IM,E,IPRINT,DDZ,HMAX,XCPB)         NOV03      59
          DIMENSION SIG(1),VNO(1),AX(1),PHIO(2,1),IQ(1),IM(1),E(3,3,1),     OUTPUT      4
         *AY(1),XC(3,1),XCP(3,1),IT(4,1),IN(4,1),PHI(1),AN(1),ANS(1),AXS(1), OUTPUT     5
         *AYS(1),PHIS(1),XCPB(1)                                            OUTPUT      6
          IAC=0                                                             OUTPUT      7
          DO 15 I=1,IEM                                                     OUTPUT      8
          IF(IM(I).LT.2)IAC=IAC+1                                           OUTPUT      9
       15 AX(I)=AY(I)=PHI(I)=0.0                                            OUTPUT     10
          DO 20 I=1,IEM                                                     OUTPUT     11
          READ(16)(ANS(K),K=1,IEM),(AXS(K),K=1,IEM),(AYS(K),K=1,IEM),       OUTPUT     12
         *(PHIS(K),K=1,IEM)                                                 OUTPUT     13
          DO 20 J=1,IEM                                                     OUTPUT     14
          AX(J)=AX(J)+SIG(I)*AXS(J)                                         OUTPUT     15
          AY(J)=AY(J)+SIG(I)*AYS(J)                                         OUTPUT     16
       20 PHI(J)=PHI(J)+SIG(I)*PHIS(J)                                      OUTPUT     17
          REWIND 16                                                         OUTPUT     18
          IF(IPRINT.EQ.1)WRITE(6,2001)                                      OUTPUT     19
          WRITE(17)IAC,ANG,XCPB(1),XCPB(2),XCPB(3),DDZ,HMAX                 OUTPUT     20
          IM(IEM+1)=0                                                       OUTPUT     21
          C1=C2=C3=C4=C5=C6=C7=C8=0.0                                       DEC03       4
          DO 5 I=1,IEM                                                      OUTPUT     23
    C.....DETERMINE AREA PROJECTION                                         OUTPUT     24
          XH1=E(1,3,I)                                                      OUTPUT     25
          XH2=E(2,3,I)                                                      OUTPUT     26
          XH3=E(3,3,I)                                                      OUTPUT     27
          ARA=PHIO(2,I)                                                     OUTPUT     28
          VX=AX(I)                                                          OUTPUT     29
          VY=AY(I)                                                          OUTPUT     30
          VZ=VNO(I)                                                         OUTPUT     31
          PH=PHI(I)                                                         OUTPUT     32
          V=SQRT(VX*VX+VY*VY+VZ*VZ)                                         OUTPUT     33
          VWX=E(1,1,I)*VX+E(1,2,I)*VY+E(1,3,I)*VZ                           OUTPUT     34
          VWY=E(2,1,I)*VX+E(2,2,I)*VY+E(2,3,I)*VZ                           OUTPUT     35
          VWZ=E(3,1,I)*VX+E(3,2,I)*VY+E(3,3,I)*VZ                           OUTPUT     36
          C1=PH*ARA+C1                                                      OUTPUT     37
          C2=VWX*ARA+C2                                                     OUTPUT     38
          C3=VWY*ARA+C3                                                     OUTPUT     39
          C4=VWZ*ARA+C4                                                     OUTPUT     40
          C5=XCP(1,I)*ARA+C5                                                OUTPUT     41
          C6=XCP(2,I)*ARA+C6                                                OUTPUT     42
          C7=XCP(3,I)*ARA+C7                                                NOV05      13
          C8=C8+ARA                                                         OUTPUT     44
          IF(IM(I+1).EQ.2)GO TO 18                                          OUTPUT     45
          C1=C1/C8                                                          OUTPUT     46
          C2=C2/C8                                                          OUTPUT     47
          C3=C3/C8                                                          OUTPUT     48
          C4=C4/C8                                                          OUTPUT     49
          C5=C5/C8                                                          OUTPUT     50
          C6=C6/C8                                                          OUTPUT     51
          C7=C7/C8                                                          OUTPUT     52
          WRITE(17)IQ(I),IM(I),C1,C2,C3,C4,C5,C6,C7,XH1,XH2,XH3,C8          OUTPUT     53
          C1=C2=C3=C4=C5=C6=C7=C8=0.0                                       NOV08      19
       18 CONTINUE                                                          OUTPUT     55
          IF(IPRINT.EQ.0)GO TO 5                                            OUTPUT     56
          WRITE(6,2000)I,IQ(I),IM(I),XC(1,I),XCP(1,I),VWX,V,PH,SIG(I)       OUTPUT     57
          WRITE(6,2002)XC(2,I),XCP(2,I),VWY                                 OUTPUT     58
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SUBROUTINE OUTPUT      73/73    OPT=1                         FTN 4.5+410        77/01/17. 11.07.10        PAGE     2

            WRITE(6,2002)XC(3,I),XCP(3,I),VWZ                                        OUTPUT      59
          5 CONTINUE                                                                 OUTPUT      60
            RETURN                                                                   OUTPUT      61
       2001 FORMAT(1H0,7HELEMENT,3X,7HREF NO.,3X,8HMOD CODE,5X,2HXC,9X,              NOV08       20
           23HXCP,7X,12HV COMPONENTS,10X,1HV,17X,3HPHI,15X,3HSIG)                    OUTPUT      63
       2000 FORMAT(1H0,3(I5,5X),2(2X,F8.4),5(F15.4,2X))                              OUTPUT      64
       2002 FORMAT(1H ,30X,2(2X,F8.4),F15.4)                                         OUTPUT      65
            END                                                                      OUTPUT      66
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
19	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
19	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.

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SUBROUTINE PRESF       73/73    OPT=1                          FTN 4.5+410         77/01/17. 11.07.10         PAGE      1

      SUBROUTINE PRESF(ISTEP,IMODE,WX,VEZ,VEY,VEX,HMIN,CW,DT,ICON,CWT,   PRESF     2
     *CGL,NCW,D,VENTRY,IPHI,NNLD,FCF)                                     JAN10     9
      COMMON A(1),SIG(1)                                                  PRESF     4
      DIMENSION DT(1),IQ(3,1),IM(3,1),PH(3,1),VWX(3,1),VWY(3,1),VWZ(3,1) NOV03    60
     *,XCP(3,3,1),XH(3,3,1),CW(1),AREA(3,1),FCP(2,1),RAD(1),IORD(1)      PRESF     6
      DIMENSION ANG(3),XCPB(3,3),DH(3),WX(1),VEZ(1),VEY(1),VEX(1),        PRESF     7
     *CWT(1),DSSS(1),HMAX(3),XC(2,1)                                      DEC01    48
C.....EQUIVALENCE SET UP FOR A MAXIMUM OF 300 ELEMENTS                    PRESF     9
C                     A(1),IQ(1)                                          PRESF    10
C                     A(3*NEL+1),IM(1)                                    PRESF    11
C                     A(6*NEL+1),PH(1)                                    PRESF    12
C                     A(9*NEL+1),VWX(1)                                   PRESF    13
C                     A(12*NEL+1),VWY(1)                                  PRESF    14
C                     A(15*NEL+1),VWZ(1)                                  PRESF    15
C                     A(18*NEL+1),XCP(1)                                  PRESF    16
C                     A(27*NEL+1),XH(1)                                   PRESF    17
C                     A(36*NEL+1),FCP(1)                                  PRESF    18
C                     A(38*NEL+1),AREA(1)                                 PRESF    19
C                     A(41*NEL+1),RAD(1)                                  PRESF    20
C                     A(42*NEL+1),IORD(1)                                 PRESF    21
C.....                A(45*MNEL+1),DSSS(1)                                DEC01    49
C.....                REQUIRED STORAGE IN A IS 45*NDIM+MNEL               DEC01    50
      EQUIVALENCE(A(1),IQ(1)),(A(901),IM(1)),(A(1801),PH(1)),(A(2701),   PRESF    23
     *VWX(1)),(A(3601),VWY(1)),(A(4501),VWZ(1)),(A(5401),XCP (1)),       PRESF    24
     *(A(8101),XH(1)),(A(10801),FCP(1)),(A(11401),AREA(1))               PRESF    25
     *,(A(12301),RAD(1)),(A(12601),IORD(1))                              PRESF    26
     *,(A(12901),XC(1)),(A(13501),DSSS(1))                               DEC01    51
C.....SET INITIAL CONDITIONS                                              PRESF    28
      XPHI=3-IPHI                                                         NOV11    73
      SCALE=.7618*D*D*VENTRY*VENTRY                                       PRESF    29
      SCALED=SCALE*D                                                      PRESF    30
      H=0.0                                                               PRESF    31
      VENTRY2=VENTRY*VENTRY                                               PRESF    32
      DO 2 I=1,3                                                          PRESF    33
      ANG(I)=DH(I)=XCPB(I,3)=XCPB(I,2)=XCPB(I,1)=0.0                     PRESF    34
      DO 2 J=1,300                                                        PRESF    35
      IQ(I,J)=IM(I,J)=0                                                   PRESF    36
      PH(I,J)=VWX(I,J)=VWY(I,J)=VWZ(I,J)=0.0                             PRESF    37
      DSSS((I-1)*300+J)=0.0                                               PRESF    38
      DO 2 K=1,3                                                          NOV05    14
    2 XCP(K,I,J)=XH(K,I,J)=0.0                                            PRESF    39
      CONVR=57.29577951                                                   PRESF    40
      ISTEP=ISTEP-2                                                       PRESF    41
      READ(17)IEM,ANG(3),XCPB(3 ,1),XCPB(3,2),XCPB(3,3),DH(3),HMAX(3)    PRESF    42
      DO 5 I=1,IEM                                                        PRESF    43
      READ(17)IQ(3,I),IM(3,I),PH(3,I),VWX(3,I),VWY(3,I),VWZ(3,I)         PRESF    44
     *,(XCP(3,J,I),J=1,3),(XH(3,J,I),J=1,3),AREA(3,I)                    PRESF    45
    5 CONTINUE                                                            PRESF    46
      IF(ISTEP.GT.1)GO TO 6                                               DEC14    15
      IF(HMIN.LT.1.E-08 .AND.ISTEP.EQ.1)GO TO 6                           DEC14    16
      WRITE(6,2003)                                                       DEC14    17
 2003 FORMAT(*1 INSUFFICIENT NUMBER OF STEPS COMPLETED.PRESSURES CAN NOT NOV05    17
     * BE CALCULATED.*)                                                   DEC14    18
      STOP                                                                DEC14    19
    6 TSSS=T=0.0                                                          NOV05    19
      DO 40 I=1,ISTEP                                                     PRESF    48
      TSSS=TSSS+VENTRY*DT(I)/D                                            NOV08    21
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      T=T+DT(I)                                                         PRESF     51
      DO 13 J=1,2                                                       PRESF     52
      DH(J)=DH(J+1)                                                     PRESF     53
      XCPB(J,1)=XCPB(J+1,1)                                             PRESF     54
      XCPB(J,2)=XCPB(J+1,2)                                             PRESF     55
      XCPB(J,3)=XCPB(J+1,3)                                             PRESF     56
      ANG(J)=ANG(J+1)                                                   PRESF     57
      HMAX(J)=HMAX(J+1)                                                 PRESF     58
      DO 13 K=1,IEM                                                     PRESF     60
      IQ(J,K)=IQ(J+1,K)                                                 PRESF     61
      IM(J,K)=IM(J+1,K)                                                 PRESF     62
      PH(J,K)=PH(J+1,K)                                                 PRESF     63
      VWX(J,K)=VWX(J+1,K)                                               PRESF     64
      VWY(J,K)=VWY(J+1,K)                                               PRESF     65
      VWZ(J,K)=VWZ(J+1,K)                                               PRESF     66
      AREA(J,K)=AREA(J+1,K)                                             PRESF     67
      DO 13 L=1,3                                                       PRESF     68
      XCP(J,L,K)=XCP(J+1,L,K)                                           PRESF     69
   13 XH(J,L,K)=XH(J+1,L,K)                                             PRESF     70
      IEM2=IEM                                                          PRESF     71
      READ(17)IEM,ANG(3),XCPB(3,1),XCPB(3,2),XCPB(3,3),DH(3),HMAX(3)    PRESF     72
      DO 15 J=1,IEM                                                     PRESF     73
      READ(17)IQ(3,J),IM(3,J),PH(3,J),VWX(3,J),VWY(3,J),VWZ(3,J)        PRESF     74
     *,(XCP(3,K,J),K=1,3),(XH(3,K,J),K=1,3),AREA(3,J)                   PRESF     75
   15 CONTINUE                                                          PRESF     76
      COST=COS((90.-ANG(2))/CONVR)                                      PRESF     77
      SINT=SIN((90.-ANG(2))/CONVR)                                      PRESF     78
      IF(HMIN.GT.1.E-08.AND.I.EQ.1)GO TO 40                             PRESF     79
      DO 25 J=1,IEM2                                                    PRESF     80
      IFAC=IQ(2,J)                                                      PRESF     81
      IPAS=IFUT=0                                                       PRESF     82
      DO 30 K=1,IEM                                                     PRESF     83
C.....DETERMINE OPTION FOR PHI DOT                                      PRESF     84
      IF(IQ(1,K).EQ.IFAC)IPAS=K                                         PRESF     85
      IF(IQ(3,K).EQ.IFAC)IFUT=K                                         PRESF     86
   30 CONTINUE                                                          PRESF     87
      IF(IPAS.EQ.0)GO TO 71                                             PRESF     88
      IF(IM(1,IPAS).EQ.0)GO TO 72                                       PRESF     89
      IF(IM(2,J).EQ.0)GO TO 74                                          PRESF     90
   71 DH1=PH1=0.0                                                       PRESF     91
      IF(IMODE.EQ.0)GO TO 73                                            PRESF     92
      IF(IPAS.EQ.0)GO TO 73                                             PRESF     93
   74 DH1=XCP(1,3,IPAS)                                                 PRESF     94
      PH1=PH(1,IPAS)                                                    PRESF     95
      GO TO 73                                                          PRESF     96
   72 DH1=XCP(1,3,IPAS)                                                 PRESF     97
      PH1=PH(1,IPAS)                                                    PRESF     98
   73 DH3=XCP(3,3,IFUT)                                                 PRESF     99
      PH3=PH(3,IFUT)                                                    PRESF    100
C.....CALCULATE PHI DOT                                                 PRESF    102
      RZ=XCP(2,3,J)-XCPB(2,3)                                           NOV03     61
      RY=XCP(2,2,J)-XCPB(2,2)                                           NOV03     62
      D1=WX(I)*DT(I)/CONVR                                              NOV08     22
      D2=WX(I+1)*DT(I+1)/CONVR                                          NOV08     23
      VZP=VEZ(I)+(RZ*(1.-COS(D1))+RY*SIN(D1))/DT(I)                     NOV05     23
      VZF=VEZ(I+1)-(RZ*(1.-COS(D2))-RY*SIN(D2))/DT(I+1)                 NOV05     24
      CWP=(VZP*DT(I)-DH(2))/(VZP*DT(I))                                 NOV07      1
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      CWF=(VZF*DT(I+1)-DH(3))/(VZF*DT(I+1))                              NOV05     26
      DELT1=(XCP(2,3,J)-DH1)/(CWP*VZP)                                   PRESF    107
      DELT2=(DH3-XCP(2,3,J))/(CWF*VZF)                                   NOV05     29
      DPH1=(PH(2,J)-PH1)/DELT1                                           NOV05     30
      DPH2=(PH3-PH(2,J))/DELT2                                           NOV05     31
      DPH=DPH1+(DPH2-DPH1)*DELT1/(DELT1+DELT2)                           NOV08     24
      V2=VWX(2,J)**2+VWY(2,J)**2+VWZ(2,J)**2                             NOV05     33
      FCP(1,J)=2.*DPH/VENTRY2                                            PRESF    113
      IF(ICON.EQ.0)FCP(1,J)=FCP(1,J)/CWT(I)                              NOV06      1
      DOTX=VEX(I)+VEX(I+1)                                               JAN10     10
      DOTY=VEY(I)+VEY(I+1)-(WX(I)+WX(I+1))*RZ/CONVR                      JAN10     11
      DOTZ=VEZ(I)+VEZ(I+1)+(WX(I)+WX(I+1))*RY/CONVR                      JAN10     12
      FCP(2,J)=(DOTX*VWX(2,J)+DOTY*VWY(2,J)+DOTZ*VWZ(2,J)-V2)/VENTRY2    JAN10     13
      IF(IM(2,J).NE.1)GO TO 60                                           DEC27     27
      FCP(1,J)=FCP(1,J)*FCF                                              DEC27     28
      FCP(2,J)=FCP(2,J)*FCF                                              DEC27     29
   60 CONTINUE                                                           DEC15      7
      IF(IM(2,J).NE.0)DSSS(IQ(2,J))=0.0                                  NOV08     26
      DSSS(IQ(2,J))=DSSS(IQ(2,J))+DELT1                                  NOV08     27
C.....TRANSFORM COORDINATES                                              PRESF    118
      XC(2,J)=SINT*RY+COST*RZ+ CGL                                       PRESF    121
      XC(1,J)=COST*RY-SINT*RZ                                            PRESF    122
   25 CONTINUE                                                           PRESF    123
      DO 50 JI=1,NCW                                                     PRESF    124
      FX=FY=FZ=SMX=SMY=SMZ=0.0                                           DEC14     20
      IFLAG=0                                                            DEC27     30
      IF(ICON.EQ.1)GO TO 83                                              NOV02      5
C.....CONSTANT ORIENTATION OUTPUT                                        PRESF    127
      VDOWN=VENTRY*COST*CW(JI)                                           PRESF    128
      H=HMAX(2)                                                          PRESF    129
      T=H/VDOWN                                                          PRESF    130
      TSAR=VENTRY*T/D                                                    PRESF    131
      WRITE(6,2005)I,H,T,TSAR,CW(JI)                                     PRESF    132
      WRITE(6,2000)                                                      PRESF    133
      DO 51 KI=1,IEM2                                                    PRESF    134
      IF(IQ(2,KI).LT.NNLD.OR.IFLAG.EQ.1)GO TO 75                         DEC27     31
      IFLAG=1                                                            DEC27     32
      WRITE(6,2012)                                                      DEC27     33
   75 CONTINUE                                                           DEC27     34
      CP=FCP(1,KI)*CW(JI)+FCP(2,KI)                                      PRESF    135
      IF(IQ(2,KI).LT.NNLD.AND.CP.LT.0)CP=0.0                             DEC27     35
      PRES=CP*.97*VENTRY2                                                PRESF    137
      IF(IQ(2,KI).GE.NNLD)PRES=0.0                                       DEC15     16
      TES=-XCP(2,3,KI)*VENTRY/(VDOWN*D)                                  PRESF    138
      FORCET=PRES*AREA(2,KI)                                             PRESF    [illegible]
      WRITE(6,2001)KI,IQ(2,KI),IM(2,KI),AREA(2,KI),XCP(2,1,KI)           PRESF    [illegible]
     *,XC(1,KI),XC(2,KI),TES,CP,PRES,FORCET                              NOV08     28
      F1=-XM(2,1,KI)*FORCET                                              DEC14     22
      F2=-XM(2,2,KI)*FORCET*XPHI                                         NOV11     74
      F3=-XM(2,3,KI)*FORCET*XPHI                                         NOV11     75
      FX=FX+F1                                                           DEC14     23
      FY=FY+F2                                                           PRESF    144
      FZ=FZ+F3                                                           PRESF    145
      RAX=XCP(2,1,KI)-XCPB(2,1)                                          DEC14     24
      RAY=XCP(2,2,KI)-XCPB(2,2)                                          DEC14     25
      RAZ=XCP(2,3,KI)-XCPB(2,3)                                          DEC14     26
      SMX=SMX+RAY*F3-RAZ*F2                                              DEC14     27
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SUBROUTINE PRESF        73/73    OPT=1                            FTN 4.5+410          77/01/17. 11.07.10        PAGE      4

            SMY=SMY-RAX*F3+RAZ*F1                                                    DEC14       28
            SMZ=SMZ+RAX*F2-F1*RAY                                                    DEC14       29
         51 CONTINUE                                                                 PRESF      147
            GO TO 81                                                                 PRESF      148
         83 CONTINUE                                                                 NOV02        6
      C.....VARIABLE ORIENTATION OUTPUT                                              PRESF      150
            WRITE(6,2006)I,HMAX(2),T,TSSS,CWT(I),CWT(I+1)                            PRESF      151
            WRITE(6,2007)(VEX(I+1)+VEX(I))/2.,(VEY(I+1)+VEY(I))/2.,                  PRESF      152
           1(VEZ(I+1)+VEZ(I))/2.,(WX(I+1)+WX(I))/2.,ANG(2)                           NOV08       31
            WRITE(6,2000)                                                            PRESF      154
            DO 82 KI=1,IEM2                                                          PRESF      155
            IF(IO(2,KI).LT.NNLD.OR.IFLAG.EQ.1)GO TO 76                               DEC27       36
            IFLAG=1                                                                  DEC27       37
            WRITE(6,2012)                                                            DEC27       38
         76 CONTINUE                                                                 DEC27       39
            CP=FCP(1,KI)+FCP(2,KI)                                                   PRESF      156
            IF(IO(2,KI).LT.NNLD.AND.CP.LT.0)CP=0.0                                   DEC27       40
            PRES=CP*.97*VENTRY2                                                      PRESF      158
            IF(IO(2,KI).GE.NNLD)PRES=0.0                                             DEC15       13
            FORCET=PRES*AREA(2,KI)                                                   PRESF      159
            TES=DSSS(IO(2,KI))*VENTRY/D                                              NOV08       32
            WRITE(6,2001)KI,IO(2,KI),IM(2,KI),AREA(2,KI),XCP(2,1,KI),XC(1,KI)        NOV08       33
           1,XC(2,KI),TES,CP,PRES,FORCET                                             NOV08       34
            F1=-XH(2,1,KI)*FORCET                                                    DEC14       31
            F2=-XH(2,2,KI)*FORCET*XPHI                                               NOV11       76
            F3=-XH(2,3,KI)*FORCET*XPHI                                               NOV11       77
            FX=FX+F1                                                                 DEC14       32
            FY=FY+F2                                                                 PRESF      164
            FZ=FZ+F3                                                                 PRESF      165
            RAX=XCP(2,1,KI)-XCPB(2,1)                                                DEC14       33
            RAY=XCP(2,2,KI)-XCPB(2,2)                                                DEC14       34
            RAZ=XCP(2,3,KI)-XCPB(2,3)                                                DEC14       35
            SMX=SMX+RAY*F3-RAZ*F2                                                    DEC14       36
            SMY=SMY-RAX*F3+RAZ*F1                                                    DEC14       37
            SMZ=SMZ+RAX*F2-F1*RAY                                                    DEC14       38
         82 CONTINUE                                                                 PRESF      167
         81 CONTINUE                                                                 PRESF      168
            IF(IPHI.EQ.1)FX=SMY=SMZ=0.0                                              DEC14       39
            FN= FZ*SINT-FY*COST                                                      PRESF      169
            FD=(FZ*COST+SINT*FY)                                                     PRESF      170
            WRITE(6,2002)FX,FD,FN,SMX,SMY,SMZ                                        DEC14       40
            CX=FX/SCALE                                                              DEC14       41
            CN=FN/SCALE                                                              PRESF      172
            CD=FD/SCALE                                                              PRESF      173
            CMX=SMX/SCALED                                                           DEC14       42
            CMY=SMY/SCALED                                                           DEC14       43
            CMZ=SMZ/SCALED                                                           DEC14       44
            WRITE(6,2011)CX,CD,CN,CMX,CMY,CMZ                                        DEC14       45
         50 CONTINUE                                                                 PRESF      176
         40 CONTINUE                                                                 PRESF      177
            RETURN                                                                   PRESF      179
       2000 FORMAT(1H0,1X,3HNO.,3X,7HREF.NO.,2X,3HMOD,5X,4HAREA,8X,1HX,9X,1HY,       PRESF      180
           *9X,1HZ,12X,2HT*,7X,2HCP,10X,1HP,9X,5HFORCE)                              PRESF      181
       2001 FORMAT(1H ,3(I4,2X),E12.4,3X,3(F9.6,1X),2X,F7.4,3X,F7.2,3X,              PRESF      182
           * 2(F12.4,1X))                                                            PRESF      183
       2002 FORMAT(1H0,5HFX = ,E15.7,2X,5HFD = ,E15.7,2X,5HFN = ,E15.7,              JAN10       14
           *2X, 6HSMX = ,E15.7,2X,6HSMY = ,E15.7,2X,6HSMZ = ,E15.7)                  JAN10       15
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SUBROUTINE PRESF       73/73    OPT=1                         FTN 4.5+410        77/01/17. 11.07.10        PAGE

          2035 FORMAT(1H0,7X,5HSTEP ,I5,3X,8HDEPTH = ,F10.7,3X,7HTIME = ,F10.7,     DEC27      41
              *3X,19HDIMENSIONLESS TIME ,F10.7,3X,17HWETTING FACTOR = ,F10.7)       PRESF     186
          2006 FORMAT(1H0/1H0,7X,5HSTEP ,I5,3X,8HDEPTH = ,F10.7,3X,7HTIME = ,       PRESF     187
              *F10.7,3X,19HDIMENSIONLESS TIME ,F10.7,3X,18HWETTING FACTORS = ,      PRESF     188
              *2F10.7)                                                              PRESF     189
          2007 FORMAT(1H ,15X,*AVERAGE VELOCITY *,3(F10.3,2X) ,* WX *,F10.2,         NOV08      36
              **ORIENTATION *,F10.3)                                                NOV08      37
          2011 FORMAT(1H ,5HCX = ,F15.7,2X, 5HCD = ,F15.7,2X, 5HCN = ,F15.7,         DEC14      48
              *2X,6HMX =  ,F15.7,2X,6HMY =  ,F15.7,2X,6HMZ =  ,F15.7)               DEC14      49
          2012 FORMAT(1H0,30X,*NO LOAD ELEMENTS*)                                   DEC15      14
               END                                                                  PRESF     193

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
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     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
     29     I       A         DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
```

```
SUBROUTINE SUAS       73/73    OPT=1                        FTN 4.5+410        77/01/17. 11.07.10         PAGE      1

            SUBROUTINE SUAS(IEM,IAVS ,NBLK,A,IP,VNO,SIG,STOR)                  JAN01       7
      C.....THIS SUBROUTINE SETS UP BLOCKS AND CALLS DECOMP AND SOLVE          DEC01      54
            DIMENSION A(1),SIG(1),IP(1),VNO(1),STOR(1)                         DEC03       5
      C.....TRANSFER NORMAL VELOCITY                                           DEC01      56
            DO 5 K=1,IEM                                                       DEC01      57
            IP(K)=K                                                            DEC22       1
          5 SIG(K)=VNO(K)                                                      DEC01      58
            IF(IEM.GT.NBLK)GO TO 15                                            DEC27      43
      C.....BLOCKS ARE NOT NECESSARY                                           DEC01      60
            DO 66 J=1,IEM                                                      DEC01      61
            READ(16)(A((I-1)*IEM+J),I=1,IEM)                                   DEC03       6
         66 CONTINUE                                                           DEC01      63
            REWIND 16                                                          DEC01      64
            IEM2=IEM*IEM                                                       DEC03       7
            CALL WRITMS(3,A,IEM2,1)                                            DEC03       8
            NR=IEM                                                             DEC01      66
            GO TO 50                                                           DEC01      67
      C.....BLOCKS ARE NEEDED                                                  DEC01      68
         15 NMAX=IAVS/IEM                                                      JAN01       8
            NUM=IEM/NMAX                                                       JAN01       9
            IF(NUM*NMAX.NE.IEM)NUM=NUM+1                                       DEC01      70
      C.....CONSTRUCT BLOCKS                                                   DEC01      71
            NR=NMAX                                                            DEC01      72
            DO 10 I=1,NUM                                                      DEC01      73
            NB=1+(I-1)*NMAX                                                    DEC01      74
            NU=I*NMAX                                                          DEC01      75
            IF(I.EQ.NUM)NU=IEM                                                 DEC01      76
            DO 20 K=1,IEM                                                      DEC01      77
            READ(16)(STOR(L),L=1,IEM)                                          DEC01      78
            IC=-1                                                              DEC12       6
            DO 20 J=NB,NU                                                      DEC03       9
            IC=IC+1                                                            DEC12       7
            IBL=IC*IEM+K                                                       DEC12       8
            A(IBL)=STOR(J)                                                     DEC12       9
         20 CONTINUE                                                           DEC12      10
            NRT=(NU-NB+1)*IEM                                                  DEC03      11
            CALL WRITMS(3,A,NRT,I)                                             DEC01      84
            REWIND 16                                                          DEC01      85
         10 CONTINUE                                                           DEC01      86
         50 CONTINUE                                                           DEC01      87
      C.....SOLVE                                                              DEC01      88
            CALL DDECOMP(IEM,NR,A,IP)                                          DEC01      89
            IF(IP(IEM).NE.0)GO TO 51                                           DEC01      90
            WRITE(6,2000)                                                      DEC01      91
       2000 FORMAT(1H1,30X,*SINGULAR MATRIX*)                                  DEC01      92
            STOP                                                               DEC01      93
         51 CONTINUE                                                           DEC01      94
            CALL DSOLVE(IEM,NR,A,SIG,IP)                                       DEC01      95
            RETURN                                                             DEC01      96
            END                                                                DEC01      97
```

```
      SUBROUTINE DDECOMP(N,NR,R,IP)                               DEC01      98
      DIMENSION R(1),IP(1)                                        DEC01      99
      INTEGER RSUBKN,RSTUB                                        DEC01     100
      DATA EPS/1.0E-10/                                           DEC01     101
      NM1=N-1                                                     DEC01     102
      NEL=N*NR                                                    DEC01     103
      IP(N)=N                                                     DEC01     104
      NBLOCK=N/NR                                                 DEC01     105
      NP=NBLOCK*NR                                                DEC01     106
      IF(NP.LT.N)NBLOCK=NBLOCK+1                                  DEC01     107
      NBNEL=NEL+NEL                                               DEC01     108
      IDX1=1                                                      DEC01     109
      RSUBKN=-N                                                   DEC01     110
      CALL READMS( 3,R,NEL,IDX1)                                  DEC01     111
      IDX1=IDX1+1                                                 DEC01     112
      DO 6 K=1,NM1                                                DEC01     113
      RSUBKN=RSUBKN+N                                             DEC01     114
      IF(RSUBKN.NE.NEL)GO TO 30                                   DEC01     115
      IF(IDX1.GT.NBLOCK)GO TO 30                                  DEC01     116
      CALL WRITMS(3,R,NEL,IDX1-1)                                 DEC01     117
      CALL READMS(3,R,NEL,IDX1)                                   DEC01     118
      IDX1=IDX1+1                                                 DEC01     119
      RSUBKN=0                                                    DEC01     120
   30 CONTINUE                                                    DEC01     121
      KP1=K+1 $ KLOW=RSUBKN+KP1 $ KHIGH=RSUBKN+N                  DEC01     122
      M=KK=K+RSUBKN                                               DEC01     123
      RM=R(M)                                                     DEC22       2
      DO 1 I=KLOW,KHIGH                                           DEC01     124
      IF(ABS(R(I)).LE.ABS(RM))GO TO 1                             DEC22       3
      RM=R(I)                                                     DEC22       4
      M=I                                                         DEC22       5
    1 CONTINUE                                                    DEC01     126
      T=-R(M)                                                     DEC01     127
      IF(ABS(T).LE.EPS)GO TO 7                                    DEC01     128
      MK=M-RSUBKN                                                 DEC22       6
      KSAVE=IP(K)                                                 DEC22       7
      IP(K)=IP(MK;                                                DEC22       8
      IP(MK)=KSAVE                                                DEC22       9
      R(M)=R(KK)                                                  DEC01     131
      R(KK)=-T                                                    DEC01     132
   12 IDX2=IDX1                                                   DEC01     133
      IF(IDX1.GT.NBLOCK)GO TO 40                                  DEC01     134
      CALL READMS(3,R(NEL+1),NEL,IDX2)                            DEC01     135
      IDX2=IDX2+1                                                 DEC01     136
   40 CONTINUE                                                    DEC01     137
      RSTUB=RSUBKN                                                DEC01     138
      IFLAG=0                                                     DEC22      10
      DO 2 I=KP1,N                                                DEC01     139
      RSTUB=RSTUB+N                                               DEC01     140
      IF(RSTUB.LT.NBNEL)GO TO 50                                  DEC01     141
      CALL WRITMS(3,R(NEL+1),NEL,IDX2-1)                          DEC01     142
      CALL READMS(3,R(NEL+1),NEL,IDX2)                            DEC01     143
      IDX2=IDX2+1                                                 DEC01     144
      RSTUB=NEL                                                   DEC01     145
   50 CONTINUE                                                    DEC01     146
      TI=R(RSTUB+MK)                                              DEC01     147
      IF(MK.EQ.K)GO TO 11                                         DEC01     148
```

```
SUBROUTINE DDECOMP     73/73    OPT=1                    FTN 4.5+410        77/01/17. 11.07.10        PAGE     2

          IF(IFLAG.EQ.1)GO TO 68                                              DEC22      11
          IFLAG=1                                                             DEC22      12
          ISTUB=1                                                             DEC22      13
       61 IF(ISTUB.EQ.IDX1-1)GO TO 69                                         DEC22      14
          CALL READMS(3,R(NEL+1),NEL,ISTUB)                                   DEC22      15
          KSTUB=NEL                                                           DEC22      16
          DO 62 KK=1,NR                                                       DEC22      17
          T2=R(KSTUB+MK)                                                      DEC22      18
          R(KSTUB+MK)=R(KSTUB+K)                                              DEC22      19
          R(KSTUB+K)=T2                                                       DEC22      20
          KSTUB=KSTUB+N                                                       DEC22      21
       62 CONTINUE                                                            DEC22      22
          CALL WRITMS(3,R(NEL+1),NEL,ISTUB)                                   DEC22      23
          ISTUB=ISTUB+1                                                       DEC22      24
          GO TO 61                                                            DEC22      25
       69 IF(IDX1.GT.NBLOCK)GO TO 63                                          DEC22      26
          CALL READMS(3,R(NEL+1),NEL,IDX2-1)                                  DEC22      27
       63 CONTINUE                                                            DEC22      28
          KSUBKN=0                                                            DEC22      29
       64 CONTINUE                                                            DEC22      30
          IF(KSUBKN.EQ.RSUBKN)GO TO 68                                        DEC22      31
          T2=R(KSUBKN+MK)                                                     DEC22      32
          R(KSUBKN+MK)=R(KSUBKN+K)                                            DEC22      33
          R(KSUBKN+K)=T2                                                      DEC22      34
          KSUBKN=KSUBKN+N                                                     DEC22      35
          GO TO 64                                                            DEC22      36
       68 CONTINUE                                                            DEC22      37
          R(RSTUB+MK)=R(RSTUB+K)                                              DEC01     149
       11 R(RSTUB+K)=T1/T                                                     DEC01     150
          DO 2 J=KP1,N                                                        DEC01     151
        2 R(RSTUB+J)=R(RSTUB+J)+R(RSTUB+K)*R(RSUBKN+J)                        DEC01     152
          IF(NBLOCK.EQ.1)GO TO 6                                              DEC12      11
          CALL WRITMS(3,R(NEL+1),NEL,NBLOCK)                                  DEC01     153
        6 CONTINUE                                                            DEC01     154
          CALL WRITMS(3,R,NEL,IDX1-1)                                         DEC01     155
          IF(P(RSUBKN+N+N).GT.EPS)RETURN                                      DEC01     156
        7 IP(N)=0                                                             DEC01     157
          RETURN                                                              DEC01     158
          END                                                                 DEC01     159
```

```
SUBROUTINE DSOLVE      73/73    OPT=1                    FTN 4.5+410        77/01/17. 11.07.10        PAGE    1

          SUBROUTINE DSOLVE(N,NR,R,B,IP)                                       DEC01     160
          DIMENSION R(1),B(1),IP(1)                                            DEC01     161
          INTEGER RSUBKN                                                       DEC01     162
          NM1=N-1                                                              DEC01     163
          NEL=N*NR                                                             DEC01     164
          NBLOCK=N/NR                                                          DEC01     165
          NP=NBLOCK*NR                                                         DEC01     166
          IF(NP.LT.N)NBLOCK=NBLOCK+1                                           DEC01     167
          IDX=1                                                                DEC01     168
          RSUBKN=0                                                             DEC01     169
          CALL READMS(3,R,NEL,IDX)                                             DEC01     170
          IDX=IDX+1                                                            DEC01     171
          DO 200 I=2,N                                                         DEC01     172
          RSUBKN=RSUBKN+N                                                      DEC01     173
          IF(RSUBKN.NE.NEL)GO TO 30                                            DEC01     174
          RSUBKN=0                                                             DEC01     175
          CALL READMS(3,R,NEL,IDX)                                             DEC01     176
          IDX=IDX+1                                                            DEC01     177
       30 CONTINUE                                                             DEC01     178
          YI=B(I)                                                              DEC01     179
          IM1=I-1                                                              DEC01     180
          DO 220 J=1,IM1                                                       DEC01     181
          YI=YI+R(RSUBKN+J)*B(J)                                               DEC01     182
      220 CONTINUE                                                             DEC01     183
          B(I)=YI                                                              DEC01     184
      200 CONTINUE                                                             DEC01     185
          IDX=NBLOCK                                                           DEC01     186
          B(N)=B(N)/R(RSUBKN +N)                                               DEC01     187
          DO 230 II=1,NM1                                                      DEC01     188
          I=N-II                                                               DEC01     189
          RSUBKN=RSUBKN-N                                                      DEC01     190
          IF(RSUBKN.LT.0)221,225                                               DEC01     191
      221 IDX=IDX-1                                                            DEC01     192
          CALL READMS(3,R,NEL,IDX)                                             DEC01     193
          RSUBKN=NEL-N                                                         DEC01     194
      225 CONTINUE                                                             DEC01     195
          XI=B(I)                                                              DEC01     196
          IP1=I+1                                                              DEC01     197
          DO 260 J=IP1,N                                                       DEC01     198
          XI=XI-R(RSUBKN+J)*B(J)                                               DEC01     199
      260 CONTINUE                                                             DEC01     200
          B(I)=XI/R(RSUBKN+I)                                                  DEC01     201
      230 CONTINUE                                                             DEC01     202
          DO 300 K=1,N                                                         DEC01     203
          M=IP(K)                                                              DEC01     204
          R(M)=B(K)                                                            DEC01     205
      300 CONTINUE                                                             DEC01     206
          DO 301 K=1,N                                                         DEC01     207
      301 B(K)=R(K)                                                            DEC01     208
          RETURN                                                               DEC01     209
          END                                                                  MATRIX     88
```

```
SUBROUTINE CENT        73/73    OPT=1                    FTN 4.5+410        77/01/17. 11.07.10        PAGE

          SUBROUTINE CENT(X,XC,IS,IEM,AREA)                                        CENT        2
          DIMENSION X(3,1),XC(3,1),IS(4,1),AREA(2,1),XTT(3,2),THETA(2)             NOV02       7
          DO 10 K=1,IEM                                                            CENT        4
          I1=IS(1,K)                                                               CENT        5
          I2=IS(2,K)                                                               CENT        6
          I3=IS(3,K)                                                               CENT        7
          I4=IS(4,K)                                                               CENT        8
C.....CALCULATE AREAS                                                              CENT        [illegible]
          A1=A2=B1=B2=C=0.0                                                        CENT       10
          DO 44 I=1,3                                                              CENT       11
          A1=A1+(X(I,I2)-X(I,I1))**2                                               CENT       12
          B1=B1+(X(I,I3)-X(I,I2))**2                                               CENT       13
          C=C+(X(I,I3)-X(I,I1))**2                                                 CENT       14
          A2=A2+(X(I,I4)-X(I,I1))**2                                               CENT       15
       44 B2=B2+(X(I,I3)-X(I,I4))**2                                               CENT       16
          DHD=(A1+B1-C)/2./SQRT(A1*B1)                                             CENT       17
          EHE=(A2+B2-C)/2./SQRT(A2*B2)                                             CENT       18
          IF(DHD.GT.1.)DHD=1.                                                      CENT       19
          IF(DHD.LT.-1.)DHD=-1.                                                    CENT       20
          IF(EHE.GT.1.)EHE=1.                                                      CENT       21
          IF(EHE.LT.-1.)EHE=-1.                                                    CENT       22
          THETA(1)=ACOS(DHD)                                                       CENT       23
          THETA(2)=ACOS(EHE)                                                       CENT       24
          AREA1=.5*SQRT(A1*B1)*SIN(THETA(1))                                       CENT       25
          AREA2=.5*SQRT(A2*B2)*SIN(THETA(2))                                       CENT       26
          AREA(2,K)=AREAT=AREA1+AREA2                                              CENT       27
C.....CALCULATE CENTROIDE IN BODY COORDINATES                                      CENT       28
          DO 60 L=1,3                                                              CENT       29
          XTT(L,1)=(X(L,I1)+X(L,I2)+X(L,I3))/3.                                    CENT       30
          XTT(L,2)=(X(L,I1)+X(L,I3)+X(L,I4))/3.                                    CENT       31
       60 CONTINUE                                                                 CENT       32
          DO 70 L=1,3                                                              CENT       33
       70 XC(L,K)=(AREA1*XTT(L,1)+AREA2*XTT(L,2))/AREAT                            CENT       34
       10 CONTINUE                                                                 CENT       35
          RETURN                                                                   CENT       36
          END                                                                      CENT       37
```

APPENDIX C

USER INSTRUCTIONS AND SAMPLE RUNS

The current version of the code can be applied to arbitrary bodies. It was developed on a CDC 6500 and requires about 105K storage octal. The grid describing the entry body may contain up to 750 nodes* and 500 elements, however, execution will terminate when more than 300 of these elements become submerged. This appendix described the available program options, necessary input cards and output format. Sample runs are provided to illustrate the use of this program.

Program Options and Required Input

Program input can be divided into three parts. In the first, the basic program options are specified:

Card No.	Variable	Format
1	CONSTANT or VARIABLE body orientation	2A4
2	PRINT or DON'T PRINT	3A4
3	ASYMMETRIC or SYMMETRIC mode	3A4

Under the CONSTANT body orientation option the entry model is assumed to retain its initial orientation and velocity throughout the entry process. As discussed previously, the natural problem variable in this case is depth rather than time. With little increase in computational time, pressures and forces can be evaluated for a number of different wetting factors, C_w. The VARIABLE body orientation option allows the velocity, orientation, wetting factor and time increments between steps to be varied. The only restriction is that the angular velocity of the body must be small enough to insure that the depth of the body increases monotonically in time. The maximum number of steps is limited to 49.

The PRINT option is used to obtain flow field and element information at each step of the calculation. It is applied only for diagnostic purposes. The second option, DON'T PRINT, is recommended and produces only grid information and the final pressures and forces on the model.

If the SYMMETRIC mode option is used, the entry model is assumed to possess planar symmetry about the y-z plane. The ASYMMETRIC option does not assume any symmetry and hence can be applied to arbitrary bodies. This mode is also used on symmetric bodies where V_x is none-zero.

---

*Storage is set up for 800 nodes. However, this must also include room for nodes generated at each step.

The second set of input cards describes the entry conditions and the required information differs depending on whether the CONSTANT or VARIABLE body orientation option is used. For the CONSTANT option the following data cards are required:

Card No.	Variables	Format
4	IMAX, D, VENTRY, ANG, SUMT, HMIN, DH, ALPHA	I5, 5X, 7F10.0
5	CGL, FCF, ANGB, NNLD	3F10.0, I5
6	NCW, CW(1), CW(2)........(CW(NCW)	I5, 5X, 7F10.0/ (8F10.0)
7	omit	

These variables are defined as follows:

IMAX — Number of steps at which pressures and loads are calculated. The present calculative procedure inserts the model into the water in a series of steps, each at a greater depth than the preceding one. When the step count becomes greater than IMAX execution is terminated

D — Diameter (in feet). This quantity is only used for calculating force coefficients

VENTRY — Entry velocity in ft/sec

ANG — Orientation of the model (in degrees) relative to the water surface (see Fig. C-1)

SUMT — Program time limit. This must correspond to the time limit on the job card

HMIN — Initial body depth (i.e., measured from the lowest point on the body). This parameter is zero if the loads are calculated from time of initial wetting. Note that if this variable is not zero pressures and forces are first calculated at HMIN + 2DH. This parameter allows pressures and forces at a particular depth to be determined without calculating the entire force-time history from initial wetting.

DH — Increment in depth in feet between successive steps. It is necessary to coordinate this variable with the specified model grid which is defined on the last set of data cards. The following apply to determining DH:

a. OBLIQUE ENTRY WITH STANDARD GRID OPTION. DH should be picked so that the average element is submerged in two steps. On models of complex shape this criteria can only be satisfied in the mean and primary consideration should be given to the portion of the body which experiences the greatest load. Generally this will be on elements whose plane is perpendicular to the direction of motion.

b. VERTICAL ENTRY WITH STANDARD GRID OPTION OR OBLIQUE ENTRY WITH THE OGIVE OPTION. For vertical entry or if the OGIVE grid option is used, elements will have a pair of side parallel to the water surface. In this case it is important to choose the step size very precisely so that each element will be submerged in exactly two steps. To insure that the top row of elements is included in an unmodified state in the code and that the next row of elements is excluded, the actual water surface should fall a small distance ε above the upper edge of the top row of element to be included as shown in Figure C-2. Here $0 < \varepsilon < \Delta h$ where Δh is defined by

$$\Delta h = \sqrt{\frac{\text{average element area}}{1000}}$$

ALPHA — Angle of attack in degrees (see Fig. C-1)

CGL — z' coordinate of the center of gravity (see Fig. C-1)

FCF — Pressure correction factor on elements with a modification code of 1. For the oblique entry of blunt bodies (nose length/diameter < 1) set to unit. For other cases use a value of .67.

ANGB — Yaw angle in degrees of $\bar{V}_I$. Velocity components in the x,y,z direction are $V_I$sin (ANGB), $-V_I$cos(ANG)cos(ANG + ALPHA) and $- V_I$cos(ANG) sin(ANG + ALPHA)

NNLD — Number of wetting factors to be used. Since the most appropriate value may not be clear, for little extra computational cost pressure and loads may be calculated for several different wetting factor values

CW — Wetting Factor. This parameter describes the rate of surface rise and is equal to the ratio of h/h' defined in Figure 1. For best results, the test cases reported on should be used as a guide. An approximate rule for determining this parameter is as follows:

(1) POINTED BODIES (ALSO INCLUDES SLIGHTLY BLUNTED ONES). Determine the angle, θ_c, between the tangent to the body surface and the body axis at both the nosetip and base of the nose. At the nose neglect any effect due to body blunting. Insert the two resulting values of θ_c in radians into:

$$C_w = \frac{1}{[1 - .396\theta_c + .287\theta_c^{\,2} - .124\theta_c^{\,3}]} \qquad \text{(C-1)}$$

Average the two calculated values of C_w to obtain the final one to be used in the code. If ALPHA is non-zero increment θ_c by ALPHA

(2) FLAT PLATES. Use a value of 1.45 for ANG > 45 degrees and 1.55 for ANG < 45.

(3) SPHERICAL BODIES. Use a value of 1.55 for near vertical entry and 1.35 for oblique entry.

The classification of an arbitrary body into one of the above categories is a matter of experience. On complex shapes classification should be based on the portion of the body sustaining the majority of the impact loading.

If the VARIABLE body orientation option is used the following data cards are required:

Card No.	Variables	Format
4	IMAX, D, VENTRY, ANG, SUMT, HMIN	15, 5X, 7F10.0
5	CGL, FCF, NNLD	2F10.0, 10X, 15
6	NVP	
7.1	VX(1), VY(1), VZ(1), CW(1), DH(1)	6F10.0
.		
.		
7.NVP	VX(NVP), VY(NVP), VZ(NVP), WX(NVP), CW(NVP), DH(NVP)	6F10.0

The variables on cards 4 and 5 are defined above. In this case, VENTRY is only used in determining the force and pressure coefficients and ANG is the initial body orientation. The body velocity, wetting factor, and increment in depth for each step is defined in cards 7.

NVP — Number of different steps at which entry conditions are specified

VX(I), VY(I), VZ(I) — Velocity components in the x,y,z directions of the center of gravity in ft/sec applied between steps I-1, and I

WX(I) — Angular velocity in degrees/sec in the pitch (y-z) plane applied between steps I-1 and I

CW(I) — Wetting factor applied between the I-1 and I step. If the value of this parameter remains constant from step to step use the instruction for determining this variable given in the CONSTANT orientation section. For the vertical entry (VX=VY=0) of pointed bodies an estimate of this parameter for each step can be obtained by:

a. Determining the depth of the entry body, H, below the original surface at the start of the step

b. Calculating the angle, θ'_c between a tangent to the body surface and the body axis, $z' = H$

c. Substituting into equation (C-1) to determine C_w. Where

$$\theta_c = \theta_c' + 90 - ANG$$

d. For blunt bodies, [(nose length)/diameter] < .75, increase this angle by 7% on ogives and decrease it by the same amount on cusps

DH(I) Increase in depth in feet of the center of gravity between steps I-1 and I. See instruction in the CONSTANT orientation entry section

The entry velocity at step I is taken to be the average of that at steps I-1 and I. It is only necessary to specify data cards for the first few steps in which the above parameters change. For steps larger than NVP the parameter values at step NVP are used.

The final set of data cards is used to define the grid on the surface of the entry body. The three available options for constructing a grid on the body surface are STANDARD, OGIVE and LIST. These can be used singularly, in combination with one another and can be called in arbitrary sequence. The only restriction is that the lowest point on the body should occur on that part of the grid constructed by the first option called. To indicate the desired options, the following input cards are required:

Card No.	Variable	Format
8	N	I5
9.1	option 1	3A4
.		
.		
9.N	option N	3A4

Here N is the number of options to be used. Recommended option are provided in Table C-1.

The grid representing the surface of the entry body should cover only the nose of the model and not the afterbody. In all cases the pressures on the afterbody are small. Furthermore, on bodies with sharp shoulders such as a disk cylinder, the flow separates at the edge of the model face. If the afterbody is gridded, the flow is required not to separate since the invicid boundary conditions are enforced at the centroid of each element. This is physically unrealistic and hence neglecting the afterbody is appropriate.

A description of the three available options follows. Under no circumstances should right angles be modeled directly. If the body under consideration has such a surface discontinuity, it should be modeled with a 89.9 or 90.1 degree angle.

STANDARD

This option is applicable to axisymmetric bodies or axisymmetric portions of arbitrary bodies. The user specifies rings along which nodes are located. Adjacent nodes are combined to form elements. A typical grid for a flat, circular plate is shown in the Figure C-3. The required input is:

Card No.	Variables	Format
10	NROWS, IANG, ISUP	315
11.1	R(1), Z(1)	2F10.0,15
•		
•		
11.NROWS	R(NROWS), Z(NROWS), IW(NROWS)	2F10.0,15

IANG — If IANG = 0, only half of the face is gridded as shown. If IANG = 1, the complete face is gridded

NROW — Number of grid rings

ISUP — If ISUP = 1, the stagnation element (number 1) is removed. This option is used for running pointed objects. For such bodies, R(1) should be very small (i.e., D/1000) but must be finite.

If ISUP = 0 this element is included.

R(I) — Radius of ring I in body fixed coordinates (x', y',z') in feet.

Z(I) — z' coordinate of ring is in feet.

IW(I) — number of elements in the area between rings I and I-1. Delete this variable on card 1. If IW = 0, elements are automatically selected so that they are approximately square.

LIST

This option requires that the user input the list of nodes and elements to be used in the run and hence is applicable to arbitrary bodies. The nodes can be read in any order, however, they are numbered sequentially for internal use in the code. Each element is constructed using nodes from the input list. The identification numbers of nodes defining the four corners of each element must be read in a clockwise order with respect to an observer on the outer surface of the element. The required input cards are:

Card No.	Variable	Format
10	NP, NE	2I5
11.1	x'(1), y'(1), z'(1)	3F10.0
.		
.		
11.NP	x'(NP), y'(NP), z'(NP)	3F10.0
12.1	IN(1,1), IN(2,1), IN(3,1), IN(4,1)	4I5
12.NE	IN(1,NE), IN(2,NE), IN(3,NE), IN(4,NE)	4I5

NP	number of node points to be read in.
NE	number of elements to be read.
x'(I), y'(I) z'(I)	location of the Ith node in body fixed coordinates (x',y',z') in feet
IN(1,I), IN(2,I), IN(3,I), IN(4,I)	Identification number of the nodes defining the four corners of the element

OGIVE

This subroutine is applicable to pointed axisymmetric bodies entering obliquely. It grids the body surface with elements having a pair of edges parallel to the water surface as shown in Figure C-4. This feature is particularly desirable for conical bodies where ANG is less than 90 degrees. Under these conditions the described code produces conical results and the complete pressure-time history can be obtained using calculated values at a single depth. This subroutine allows elements to be packed near the water surface and minimizes the need to use the local similarity assumption. Use of this subroutine is also recommended for examples in which normal force is of importance. Alignment of elements with the water surface will produce more accurate results than the STANDARD grid option. If this subroutine is used to grid non-conical bodies, the constructed element will be slightly non-planar, however, this does not seriously effect the calculations.

Card No.	Variable	Format
10	NROWS, NBODY, IANG	3I5
11.1	R(1), Z(1)	2F10.0
.		
.		
11.NBODY	R(NBODY), Z(NBODY)	2F10.0
12.1	H(1), B(1), IW(1)	2F10.0,I5
12.NROWS	H(NROWS), B(NROWS), IW(NROWS)	2F10.0,I5

Here cards 11 are used to specify the body shape while cards 12 define the grid. Up to 50 points may be used to define the body. Between these points the body is defined by linear interpolation.

The above variables are defined as:

NROWS — Number of element rows

NBODY — Number of points defining the body geometry

IANG — If IANG = 0 only the right half of the body is gridded. If IANG = 1 the entire body is gridded

R(I), Z(I) — Polar coordinates of body profile in feet. $R = (x'^2 + y'^2)^{1/2}$, $Z = z'$. R(1) and Z(1) must be zero

H(I) — z' coordinate of the upper edge of the Ith element row in the y'-z' plane in feet

B(I) — Orientation in degrees of the entry body axis with respect to the water surface at the end of step 2I. If the entry is under constant condition B(I) is equal to ANG

IW(I) — Number of elements in the Ith row. Must be specified.

SAMPLE RUNS

Four sample runs have been provided to illustrate the use of various code options. In each case a brief discussion is given of the entry problem and its particular peculiarities. This is followed by a listing of the input cards and the resulting output . In the final section of this appendix a discussion is given of the output format. Table C-2 gives a brief outline of the four cases to be present.

Example 1

A disk cylinder entering at 60 degrees and 100 ft/sec is modeled using a coarse, 12-element STANDARD grid. Consistent with the preceding discussion, the grid, shown in Sketch 3, covers only the face of the model. Noting that the distance between successive grid ring is .05 ft, an increment in depth of .0125 feet is chosen insuring that the average element is submerged in two steps. Consistent with instructions, C_w and FCF are set to 1.45 and 1 respectively.

Example 2

The vertical entry of a 45-degree half-angle cone at 20 degrees incidence is studied using an OGIVE grid with 10 rows of elements and 8 elements in each row. This problem is conically similar indicating that pressures and loads are adequately defined by considering only a single depth, hence IMAX = 1. HMIN is selected as .47814 ft which places the water level just above the 8th element row and DH is set at .02988 ft to insure that each element is submerged in two steps exactly. Pressures are calculated at HMIN + 2DH which corresponds to a level just above the 9th element row. Two values of C_w are used. These are arrived at by substituting θ_c ± ALPHA in equation (C-1). The larger value is most appropriate on the windward ray of the cone while the smaller applies to the leeward ray.

Example 3

The vertical entry of an ogive traveling at 50 ft/sec is considered under the variable entry option. A STANDARD grid consisting of 90 elements is constructed on the body nose. The entry velocity and orientation are fixed throughout but the wetting factor is allowed to vary from step to step. The value of this parameter is determined using the procedure outlined for calculating CW under the VARIABLE entry option. The increments in depth between successive steps, DH(I), are selected with care to insure that the water surface is a small distance, ϵ, above the upper edge of elements adjacent to the water surface at even numbered steps. In examining the total calculated drag a higher degree of reliability is placed on result obtained at even numbered steps.

Example 4

Entry of a disk cylinder at 60 degrees and 100 ft/sec is considered in this example. This case is included to demonstrate the use of no load elements in modeling the water-cavity interface. Each depth must be considered separately since the cavity shape changes in time. Accordingly, IMAX is set to 1. The STANDARD grid option is used to define elements on the face of the disk cylinder while LIST is applied to define a ring of no load elements extending from the edge of the disk cylinder surface to the effective planar surface. The depth of interest is taken to be .15 and hence HMIN and DH are defined as .125 and .0125 respectively. Several runs are made and the positions of the no loads elements are adjusted until the calculated CP value on each of the no load elements is near zero. The illustrated output is the final run only.

PROGRAM OUTPUT

Under the initial heading of I,X,Y,Z,XC,YC,ZC are listed all nodes. Column I is the node identification number, columns X,Y,Z, are the node positions in the x',y',z' coordinates and XP, YP, ZP are the node positions in x,y,z coordinates when h = 0. The second section of the output lists the constructed elements. The integers under the heading ELEMENT are the element reference numbers, XC,YC,ZC are the coordinates of the element centroid referenced to the axes x',y',z' and RC and TC are the radial location measured from the z' axis and the angular position measured from the +y' axis of the element centroid. The third section of output indicates numbers of the completed steps and the time required to execute that particular step. If a problem occurs during execution and the program does not terminate normally, the step in which the problem occurred can thus be determined.

The remainder of the output defines the loading on body at each step in the entry of the model. At each step the program calculates the time and dimensionless time ($V_I t/D$) from initial impact. This is followed by a listing of the submerged elements. The reference number (i.e., ref. no.) of an element is the original identification number assigned to it while its number (no.) is a temporary identification parameter for the particular depth in question. The integer under the heading of MOD identifies whether the element is modified or split. The codes 0,1 and 2 refers to unmodified, modified, and split elements respectively. The area of each element is that of its submerged portion. Also listed for each element are its pressure coefficient(CP), centroid depth in dimensionless time (T*), pressure (P), and total load (force). The output for each depth is concluded by providing:

FX	force along the x axis
CX	X force coefficient $(FX/((\pi\frac{D^2}{4})1/2\ \rho\ V_I^{\ 2})$
FD	drag force
CD	drag force coefficient $\sim FD/((\pi D^2/4)\frac{1}{2}\ \rho\ V_I^{\ 2})$
FN	normal force (i.e., in the -y' direction)
FD	normal force coefficient $(FN/((\frac{\pi D^2}{4})1/2\ \rho\ V_I^{\ 2})$
SMX	x component of moment taken about the model center of gravity
MX	x moment coefficient $SMX/((\frac{\pi D^3}{4})\frac{1}{2}\ \rho\ V_I^{\ 2})$
SMY	y component of the moment about model center of gravity
MY	y moment coefficient $SMY/((\frac{\pi D^3}{4})\frac{1}{2}\ \rho\ V_I^{\ 2})$
SMZ	z component of moment taken about the model center of gravity
MZ	z moment coefficient $SMZ/((\frac{\pi D^3}{4})\frac{1}{2}\ \rho\ V_I^{\ 2})$

TABLE C-1

RECOMMENDED GRID OPTIONS

TYPE OF BODY	RECOMMENDED OPTION		COMMENTS
	Vertical Entry	Oblique Entry	
Axisymmetric Pointed	STANDARD OGIVE	OGIVE	
Axisymmetric Blunt	STANDARD	STANDARD	
All other bodies	LIST	LIST	On pointed bodies, it is advisable to construct elements with edges parallel to water surface as done in OGIVE

TABLE C-2

SAMPLE RUNS

Example	Body	Conditions	Type of Entry	Grid Options	No Load Elements
1	disk cylinder	ANG = 60 VENTRY = 100 ALPHA = 0	CONSTANT orientation	STANDARD	none
2	45-degree half-angle cone	ANG = 70 VENTRY = 100 ALPHA = 20	CONSTANT orientation	OGIVE	none
3	ogive	ANG = 90 VENTRY = 50 ALPHA = 0	VARIABLE orientation	STANDARD	none
4	disk cylinder	ANG = 60 VENTRY = 100 ALPHA = 0	CONSTANT orientation	STANDARD LIST	yes

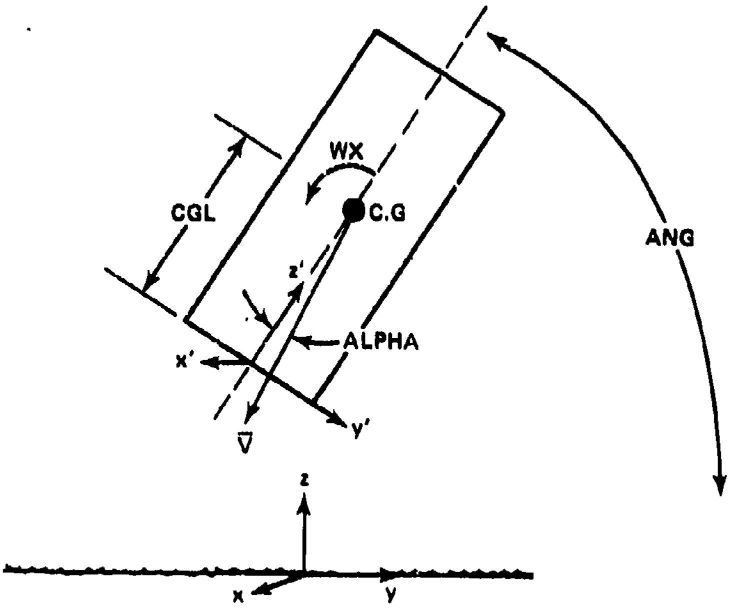

FIG. C-1

TERMS DEFINED

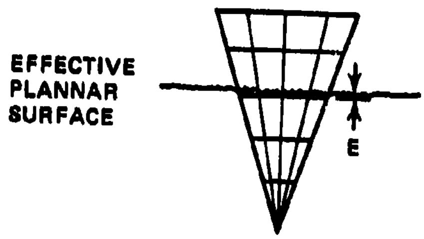

FIG. C-2 PROFILE OF CONE GRID

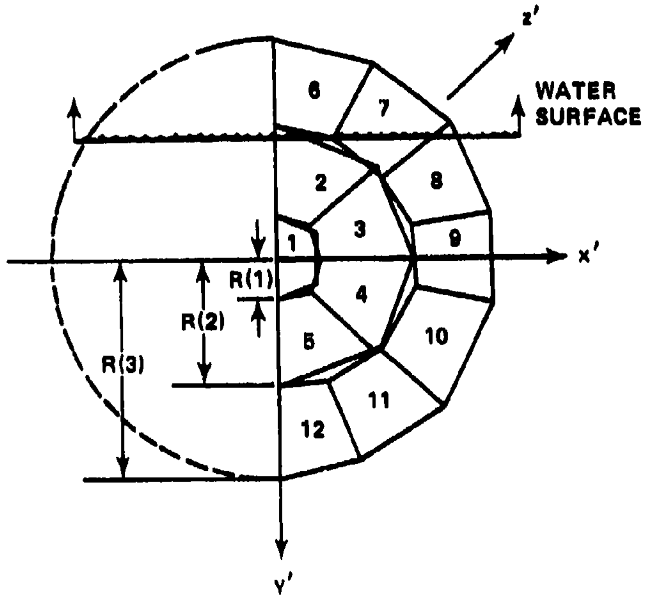

FIG. C-3 GRID OF A CIRCULAR PLATE

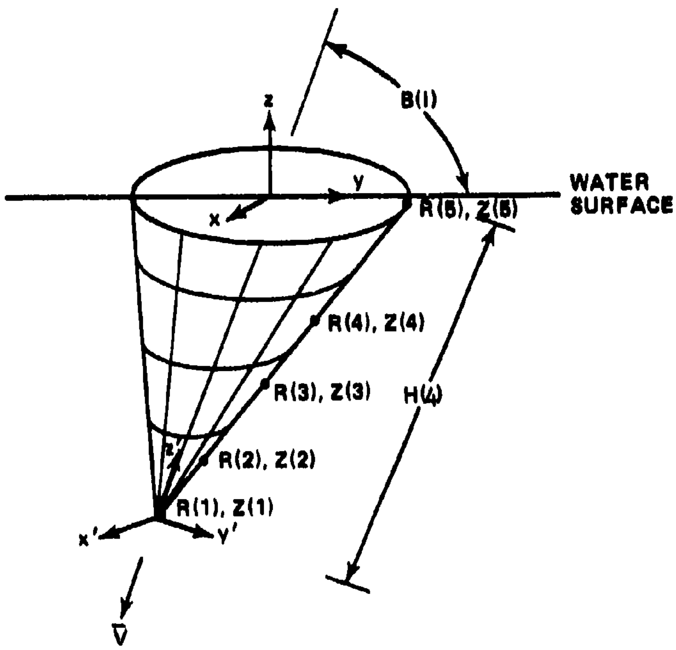

FIG. C-4

ELEMENTS HAVING A PAIR OF EDGES PARALLEL TO THE WATER

DATA CARDS FOR EXAMPLE 1

```
CONSTANT
DON'T PRINT
SYMMETRIC
   11     .250      100.      60.       50.       0.        .0125     0.
0.        1.        0.              0
    1     1.45
    1
STANDARD
    3     0    0
.025      0.              1
.075      0.              4
.125      0.              7
```

DATA CARDS FOR EXAMPLE 2

```
CONSTANT
DON'T PRINT
SYMMETRIC
    1     1.2       100.      70.       250.      .47814    .029885   20.
0.        .67       0.              0
    2     1.359305  1.113171
    1
OGIVE
   10     3    G
0.        0.
.25       .25
1.        1.
.1        70.             8
.2        70.             8
.3        70.             8
.4        70.             8
.5        70.             8
.6        70.             8
.7        70.             8
.8        70.             8
.9        70.             8
1.0       70.             8
```

DATA CARDS FOR EXAMPLE 3

```
VARIABLE
DONT PRINT
SYMMETRIC
   18     1.         50.        90.       300.        0.
0.        .67        0.           0
   18
0.        0.         -50.       0.        1.2622     .050001
0.        0.         -50.       0.        1.2520     .05
0.        0.         -50.       0.        1.2329     .05
0.        0.         -50.       0.        1.2242     .05
0.        0.         -50.       0.        1.2075     .05
0.        0.         -50.       0.        1.1995     .05
0.        0.         -50.       0.        1.1838     .05
0.        0.         -50.       0.        1.1761     .05
0.        0.         -50.       0.        1.1607     .05
0.        0.         -50.       0.        1.1530     .05
0.        0.         -50.       0.        1.1377     .05
0.        0.         -50.       0.        1.1300     .05
0.        0.         -50.       0.        1.1141     .05
0.        0.         -50.       0.        1.1060     .05
0.        0.         -50.       0.        1.0895     .05
0.        0.         -50.       0.        1.0811     .05
0.        0.         -50.       0.        1.0671     .05
0.        0.         -50.       0.        1.0615     .05
   1
STANDARD
   10     0     1
.0001     0.           8
.1124     .1           8
.2635     .2           8
.2785     .3           8
.3404     .4           8
.3913     .5           8
.4323     .6           8
.4645     .7           8
.4885     .8           8
.58       .870         8
```

DATA CARDS FOR EXAMPLE 4

```
CONSTANT
DON'T PRINT
SYMMETRIC
    1      .250       100.       60.       30.       .1250      .0125      0.
0.         1.         0.            13
    1      1.45
    2
STANDARD
LIST
    3    0    0
.025      0.          1
.075      0.          4
.125      0.          7
    8    7
0.         -5.0       3.23
1.22       -3.55      3.23
1.85       -2.10      3.23
1.75       -.4100     3.23
.99        .45        3.23
.80        .67        3.23
.64        .80        3.23
0.         .90        3.23
   31   32   24   23
   32   33   25   24
   33   34   26   25
   34   35   27   26
   35   36   28   27
   36   37   29   28
   37   38   30   29
```

EXAMPLE 1

```
*******PROGRAM OPTIONS*******
CONSTANT BODY ORIENTATION
DON*T PRINT
SYMMETRIC  CONFIGURATION

*******PROBLEM PARAMETERS*******
      DIAMETER  .2500 FT
      ENTRY VELOCITY    100.000(FT/SEC)
      BODY ORIENTATION ANGLE  60.00 DEGREES
INITIAL DEPTH   0.00000 FT   TERMINATION STEP 11
   INITIAL PRESSURE CORRECTION FACTOR =  1.0000
CENTROIDE COORDINATES      0.00000      0.00000      0.00000
      INCREMENT IN DEPTH   .0125000
      ANGLE OF ATTACK    0.00
         YAW ANGLE    0.00

      WETTING FACTORS
          1.45000

*******GRID OPTIONS*******
      STANDARD
```

GRID SIZE

R	Z	NUMBER
.025000	0.000000	1
.075000	0.000000	4
.125000	0.000000	7

NODE	X	Y	Z	XP	YP	ZP
1	0.0000	-.0250	0.0000	0.0000	-.1299	.0750
2	.0217	-.0125	0.0000	.0217	-.1191	.0687
3	.0217	.0125	0.0000	.0217	-.0974	.0562
4	-.0000	.0250	0.0000	-.0000	-.0866	.0500
5	0.0000	-.0250	0.0000	0.0000	-.1299	.0750
6	.0177	-.0177	0.0000	.0177	-.1236	.0713
7	.0250	.0000	0.0000	.0250	-.1083	.0625
8	.0177	.0177	0.0000	.0177	-.0929	.0537
9	-.0000	.0250	0.0000	-.0000	-.0866	.0500
10	0.0000	-.0750	0.0000	0.0000	-.1732	.1000
11	.0530	-.0530	0.0000	.0530	-.1542	.0890
12	.0750	.0000	0.0000	.0750	-.1083	.0625
13	.0530	.0530	0.0000	.0530	-.0623	.0360
14	-.0000	.0750	0.0000	-.0000	-.0433	.0250
15	0.0000	-.0750	0.0000	0.0000	-.1732	.1000
16	.0325	-.0676	0.0000	.0325	-.1668	.0963
17	.0586	-.0468	0.0000	.0586	-.1488	.0859
18	.0731	-.0167	0.0000	.0731	-.1227	.0708
19	.0731	.0167	0.0000	.0731	-.0938	.0542
20	.0586	.0468	0.0000	.0586	-.0678	.0391
21	.0325	.0676	0.0000	.0325	-.0497	.0287
22	-.0000	.0750	0.0000	-.0000	-.0433	.0250
23	0.0000	-.1250	0.0000	0.0000	-.2165	.1250
24	.0542	-.1126	0.0000	.0542	-.2058	.1188
25	.0977	-.0779	0.0000	.0977	-.1757	.1015
26	.1219	-.0278	0.0000	.1219	-.1323	.0764
27	.1219	.0278	0.0000	.1219	-.0842	.0486
28	.0977	.0779	0.0000	.0977	-.0408	.0235
29	.0542	.1126	0.0000	.0542	-.0107	.0062
30	-.0000	.1250	0.0000	-.0000	-.0000	-.0000

ELEMENT	1	2	3	4	XC	YC	ZC	RC	TC	AREA

1	1	2	3	4	.00962	.00000	0.00000	.00962	90.000	.8119E-03
2	10	11	6	5	.01915	-.04623	0.00000	.05004	157.500	.1768E-02
3	11	12	7	6	.04623	-.01915	0.00000	.05004	112.500	.1768E-02
4	12	13	8	7	.04623	.01915	0.00000	.05004	67.500	.1768E-02
5	13	14	9	8	.01915	.04623	0.00000	.05004	22.500	.1768E-02
6	23	24	16	15	.07215	-.09703	0.00000	.09952	167.143	.2169E-02
7	24	25	17	16	.06205	-.07781	0.00000	.09952	141.429	.2169E-02
8	25	26	18	17	.08967	-.04318	0.00000	.09952	115.714	.2169E-02
9	26	27	19	18	.09952	.00000	0.00000	.09952	90.000	.2169E-02
10	27	28	20	19	.08967	.04318	0.00000	.09952	64.286	.2169E-02
11	28	29	21	20	.06205	.07781	0.00000	.09952	38.571	.2169E-02
12	29	30	22	21	.07215	.09703	0.00000	.09952	12.857	.2169E-02

STEP 1 COMPLETE.CP TIME FOR STEP IS .32300

STEP 2 COMPLETE.CP TIME FOR STEP IS .57700

STEP 3 COMPLETE.CP TIME FOR STEP IS .82000

STEP 4 COMPLETE.CP TIME FOR STEP IS 1.16300

STEP 5 COMPLETE.CP TIME FOR STEP IS 1.06300

STEP 6 COMPLETE.CP TIME FOR STEP IS 2.15100

STEP 7 COMPLETE.CP TIME FOR STEP IS 2.42700

STEP 8 COMPLETE.CP TIME FOR STEP IS 2.42000

STEP 9 COMPLETE.CP TIME FOR STEP IS 2.35100

STEP 10 COMPLETE.CP TIME FOR STEP IS 1.99100

STEP 11 COMPLETE.CP TIME FOR STEP IS 1.31400

STEP 12 COMPLETE.CP TIME FOR STEP IS 1.83900

STEP 1 DEPTH = .0125000 TIME = .0000995 DIMENSIONLESS TIME .0398173 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	11	1	.1382E-03	.057485	.104207	.000000	.0067	6.84	.6637E+05	.9174E+01
2	12	1	.9818E-03	.023047	.109961	.000000	.0159	5.80	.5623E+05	.5521E+02

FX = 0. FD = .1287743E+03 FN = .1087915+-07 SMX = .1405459E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2704632 CN = .0000000 MX = .1180748 MY = 0.0000000 MZ = 0.0000000

STEP 2 DEPTH = .0250000 TIME = .0001991 DIMENSIONLESS TIME .0796345 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	10	1	.7481E-05	.096973	.075979	.000000	.0016	8.88	.8615E+05	.6445E+00
2	11	1	.1217E-02	.063621	.087643	.000000	.0201	5.65	.5476E+05	.6667E+02
3	12	2	.2035E-02	.022097	.098644	.000000	.0377	4.47	.4331E+05	.8815E+02

FX = 0. FD = .3109259E+03 FN = .2625712E-07 SMX = .2917491E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .6530341 CN = .0000000 MX = .2451029 MY = 0.0000000 MZ = 0.0000000

STEP 3 DEPTH = .0375000 TIME = .0002986 DIMENSIONLESS TIME .1194518 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	4	1	.6505E-05	.052441	.051011	.000000	.0016	10.40	.1008E+06	.6559E+00
2	5	1	.7387E-03	.029308	.058489	.000000	.0135	7.85	.7619E+05	.5629E+02
3	10	1	.6772E-03	.090536	.059312	.000000	.0148	6.44	.6246E+05	.4230E+02
4	11	2	.2156E-02	.062073	.077987	.000000	.0446	4.38	.4248E+05	.9159E+02
5	12	0	.2169E-02	.022146	.097029	.000000	.0749	3.10	.3004E+05	.6517E+02

FX = 0. FD = [illegible] FN = [illegible] SMX = [illegible] SMY = 0. SMZ = 0.

SMZ = 0.

CX = 0.0000000 CD = 1.0753206 CN = .0000000 MX = .3242845 MY = 0.0000000 MZ = 0.0000000

STEP 4 DEPTH = .0500000 TIME = .0003982 DIMENSIONLESS TIME .1592690 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	4	1	.5557E-03	.047559	.034344	.000000	.0149	7.31	.7095E+05	.3943E+02
2	5	2	.1676E-02	.019420	.047527	.000000	.0359	5.78	.5603E+05	.9392E+02
3	9	1	.1736E-04	.117755	.025939	.000000	.0015	11.59	.1124E+06	.1952E+01
4	10	2	.2001E-02	.090150	.044940	.000000	.0318	5.12	.4970E+05	.9947E+02
5	11	0	.2169E-02	.062052	.077811	.000000	.0841	2.98	.2886E+05	.6261E+02
6	12	0	.2169E-02	.022146	.097029	.000000	.1147	2.60	.2520E+05	.5468E+02

FX = 0. FD = .7041272E+03 FN = .5949187E-07 SMX = .4103236E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.4789704 CN = .0000000 MX = .3447187 MY = 0.0000000 MZ = 0.0000000

STEP 5 DEPTH = .0625000 TIME = .0004977 DIMENSIONLESS TIME .1990863 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	1	.4059E-03	.009623	.009722	.000000	.0155	8.07	.7823E+05	.3176E+02
2	4	0	.1768E-02	.046234	.019151	.000000	.0305	5.21	.5056E+05	.8937E+02
3	5	0	.1768E-02	.019151	.046234	.000000	.0736	3.79	.3680E+05	.6505E+02
4	9	1	.1085E-02	.099524	.011358	.000000	.0181	6.39	.6201E+05	.6726E+02
5	10	0	.2169E-02	.089668	.043182	.000000	.0688	3.27	.3173E+05	.6883E+02
6	11	0	.2169E-02	.062052	.077811	.000000	.1239	2.43	.2359E+05	.5117E+02
7	12	0	.2169E-02	.022146	.097029	.000000	.1545	2.23	.2161E+05	.4688E+02

FX = 0. FD = .8406498E+03 FN = .7101335E-07 SMX = .3458912E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.7656053 CN = .0000000 MX = .2905885 MY = 0.0000000 MZ = 0.0000000

STEP 6 DEPTH = .0750000 TIME = .0005973 DIMENSIONLESS TIME .2389036 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.0398	5.09	.4934E+05	.4006E+02
2	2	1	.9153E-04	.014226	-.022559	-.000000	.0039	10.83	.1050E+06	.9613E+01
3	3	2	.1212E-02	.045627	-.012185	-.000000	.0204	7.33	.7107E+05	.8614E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.0703	3.88	.3760E+05	.6646E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.1135	3.04	.2947E+05	.5210E+02
6	8	1	.1679E-03	.083923	-.022230	-.000000	.0044	10.26	.9954E+05	.1672E+02
7	9	2	.2152E-02	.099377	.000209	.000000	.0402	4.96	.4810E+05	.1035E+03
8	10	0	.2169E-02	.089668	.043182	.000000	.1086	2.52	.2449E+05	.5312E+02
9	11	0	.2169E-02	.062052	.077811	.000000	.1637	2.09	.2026E+05	.4396E+02
10	12	0	.2169E-02	.022146	[illegible]	.000000	.1944	[illegible]	.1899E+05	.4121E+02

FX = 0. FD = .1025785E+04 FN = .8665847E-07 SMX = .2355469E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.1544448 CN = .0000000 MX = .1978659 MY = 0.0000000 MZ = 0.0000000

STEP 7 DEPTH = .0875000 TIME = .0006968 DIMENSIONLESS TIME .2787208 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.0796	3.90	.3787E+05	.3075E+02
2	2	1	.1029E-02	.018980	-.037436	-.000000	.0200	7.19	.6972E+05	.7175E+02
3	3	2	.1761E-02	.046211	-.019033	-.000000	.0493	5.40	.5239E+05	.9226E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.1101	3.03	.2941E+05	.5199E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.1533	2.57	.2490E+05	.4401E+02
6	7	1	.1315E-04	.058637	-.048921	-.000000	.0017	12.02	.1166E+06	.1533E+01
7	8	2	.1492E-02	.089274	-.035861	-.000000	.0225	6.35	.6160E+05	.9192E+02
8	9	0	.2169E-02	.099524	.000000	.000000	.0796	3.01	.2922E+05	.6339E+02
9	10	0	.2169E-02	.089668	.043182	.000000	.1484	2.09	.2027E+05	.4397E+02
10	11	0	.2169E-02	.062052	.077811	.000000	.2036	1.83	.1778E+05	.3858E+02
11	12	0	.2169E-02	.022146	.097029	.000000	.2342	1.74	.1692E+05	.3670E+02

FX = 0. FD = .1133788E+04 FN = .9577343E-07 SMX = .7357570E+01 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.3811142 CN = .0000000 MX = .0618121 MY = 0.0000000 MZ = 0.0000000

STEP 8 DEPTH = .1000000 TIME = .0007963 DIMENSIONLESS TIME .3185381 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.1195	2.98	.2888E+05	.2345E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.0458	4.29	.4159E+05	.7353E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.0890	3.39	.3286E+05	.5809E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.1580	2.48	.2408E+05	.4257E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.1931	2.20	.2130E+05	.3766E+02
6	6	1	.1341E-03	.022886	-.072524	-.000000	.0039	12.12	.1176E+06	.1577E+02
7	7	1	.9528E-03	.060846	-.065238	-.000000	.0155	7.19	.6973E+05	.6639E+02
8	8	2	.2162E-02	.089643	-.043868	-.000000	.0509	4.53	.4396E+05	.9504E+02
9	9	0	.2169E-02	.099524	.000000	.000000	.1195	2.18	.2110E+05	.4578E+02
10	10	0	.2169E-02	.089668	.043182	.000000	.1882	1.79	.1733E+05	.3759E+02
11	11	0	.2169E-02	.062052	.077811	.000000	.2434	1.61	.1567E+05	.3398E+02
12	12	0	.2169E-02	.022146	.097029	.000000	.2740	1.55	.1506E+05	.3267E+02

FX = 0. FD = .1125033E+04 FN = .9505129E-07 SMX = -.8170671E+01 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.3428937 CN = .0000000 MX = -.0686431 MY = 0.0000000 MZ = 0.0000000

STEP 9 DEPTH = .1125000 TIME = .0008959 DIMENSIONLESS TIME .3583553 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.1593	2.41	.2334E+05	.1895E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.0856	3.40	.3298E+05	.5831E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.1268	2.56	.2481E+05	.4386E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.1898	2.07	.2008E+05	.3549E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.2329	1.90	.1840E+05	.3252E+02
6	6	1	.1188E-02	.021401	-.086337	-.000000	.0218	6.76	.6560E+05	.7791E+02
7	7	2	.2031E-02	.062363	-.075015	-.000000	.0382	5.35	.5192E+05	.1055E+03
8	8	0	.2169E-02	.089668	-.043182	-.000000	.0985	2.51	.2436E+05	.5285E+02
9	9	0	.2169E-02	.099524	.000000	.000000	.1593	1.75	.1700E+05	.3689E+02
10	10	0	.2169E-02	.089668	.043182	.000000	.2280	1.54	.1490E+05	.3233E+02
11	11	0	.2169E-02	.062052	.077811	.000000	.2832	1.42	.1379E+05	.2992E+02
12	12	0	.2169E-02	.022146	.097029	.000000	.3138	1.38	.1339E+05	.2904E+02

FX = 0. FD = .1107051E+04 FN = .9353789E-07 SMX = -.2367068E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.3251276 CN = .0000000 MX = -.1988611 MY = 0.0000000 MZ = 0.0000000

STEP 10 DEPTH = .1250000 TIME = .0009954 DIMENSIONLESS TIME .3981776 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.1991	1.86	.1804E+05	.1465E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.1254	2.27	.2201E+05	.3891E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.1686	1.89	.1836E+05	.3246E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.2296	1.67	.1620E+05	.2864E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.2727	1.58	.1534E+05	.2712E+02
6	6	0	.2169E-02	.022146	-.097029	-.000000	.0445	3.34	.3238E+05	.7026E+02
7	7	0	.2169E-02	.062052	-.077811	-.000000	.0752	2.33	.2264E+05	.4911E+02
8	8	0	.2169E-02	.089668	-.043182	-.000000	.1383	1.63	.1580E+05	.3429E+02
9	9	0	.2169E-02	.099524	.000000	.000000	.1991	1.39	.1347E+05	.2923E+02
10	10	0	.2169E-02	.089668	.043182	.000000	.2679	1.28	.1244E+05	.2700E+02
11	11	0	.2169E-02	.062052	.077811	.000000	.3230	1.21	.1178E+05	.2555E+02
12	12	0	.2169E-02	.022146	.097029	.000000	.3536	1.19	.1155E+05	.2505E+02

FX = 0. FD = .8045298E+03 FN = .6797563E-07 SMX = -.1430395E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.6897432 CN = .0000000 MX = -.1201697 MY = 0.0000000 MZ = 0.0000000

STEP 11 DEPTH = .1375000 TIME = .0010950 DIMENSIONLESS TIME .4379899 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.2389	1.51	.1463E+05	.1188E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.1653	1.57	.1521E+05	.2689E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.2084	1.49	.1446E+05	.2556E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.2694	1.41	.1370E+05	.2422E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.3125	1.37	.1332E+05	.2354E+02
6	6	0	.2169E-02	.022146	-.097029	-.000000	.0844	1.62	.1570E+05	.3406E+02
7	7	0	.2169E-02	.062052	-.077811	-.000000	.1150	1.41	.1369E+05	.2971E+02
8	8	0	.2169E-02	.089668	-.043182	-.000000	.1781	1.30	[illegible]	[illegible]

9	9	0	.2169E-02	.999524	.000000	.000000	.2389	1.17	.1134E+05	.2459E+02
10	10	0	.2169E-02	.989668	.043182	.000000	.3077	1.12	.1082E+05	.2347E+02
11	11	0	.2169E-02	.962052	.077811	.000000	.3628	1.07	.1040E+05	.2255E+02
12	12	0	.2169E-02	.922146	.097029	.000000	.3934	1.06	.1026E+05	.2226E+02

FX = 0. FD = .5911595E+03 FN = .4994672E-07 SMX = -.4055373E+01 SMY = 0. SMZ = 0.

CX = 0.0000000 CD = 1.2416057 CN = .0000000 MX = -.0340698 MY = 0.0000000 MZ = 0.0000000

EXAMPLE 2

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*******PROGRAM OPTIONS*******
CONSTANT BODY ORIENTATION
DON'T PRINT
SYMMETRIC  CONFIGURATION

*******PROBLEM PARAMETERS*******
        DIAMETER 1.2000 FT
        ENTRY VELOCITY     100.000(FT/SEC)
        BODY ORIENTATION ANGLE  70.00 DEGREES
   INITIAL DEPTH     .47814 FT   TERMINATION STEP  1
      INITIAL PRESSURE CORRECTION FACTOR =    .6700
CENTROIDE COORDINATES      0.00000      0.00000      0.00000
       INCREMENT IN DEPTH    .0298850
        ANGLE OF ATTACK    20.00
           YAW ANGLE     0.00

        WETTING FACTORS
           1.35931
           1.11317

*******GRID OPTIONS*******
        OGIVE

        SYMMETRY =      0
```

BODY PROFILE

R	Z
0.000000	0.000000
.250000	.250000
1.000000	1.000000

GRID SIZE

H	B	NUMBER
.100000	70.000000	8
.200000	70.000000	8
.300000	70.000000	8
.400000	70.000000	8
.500000	70.000000	8
.600000	70.000000	8
.700000	70.000000	8
.800000	70.000050	8
.900000	70.000000	8
1.000005	70.000000	8

NODE	X	Y	Z	XP	YP	ZP
1	0.0000	-.0001	.0001	0.0000	-.0001	-.4780
2	.0000	-.0001	.0001	.0000	-.0001	-.4780
3	.0001	-.0001	.0001	.0001	-.0000	-.4780
4	.0001	-.0000	.0001	.0001	-.0000	-.4780
5	.0001	.0000	.0001	.0001	.0000	-.4780
6	.0001	.0000	.0001	.0001	.0001	-.4781
7	.0001	.0001	.0001	.0001	.0001	-.4781
8	.0000	.0001	.0001	.0000	.0001	-.4781
9	-.0000	.0001	.0001	-.0000	.0001	-.4781
10	0.0000	-.0466	.0466	0.0000	-.0279	-.4184
11	.0182	-.0440	.0476	.0182	-.0250	-.4184
12	.0358	-.0358	.0506	.0358	-.0163	-.4184
13	.0516	-.0214	.0558	.0516	-.0010	-.4184
14	.0636	.0000	.0636	.0636	.0218	-.4184
15	.0683	.0283	.0739	.0683	.0518	-.4184
16	.0606	.0606	.0856	.0605	.0862	-.4184
17	.0367	.0885	.0958	.0367	.1160	-.4184
18	-.0000	.1000	.1000	-.0000	.1282	-.4184
19	0.0000	-.0933	.0933	0.0000	-.0557	-.3586
20	.0364	-.0879	.0952	.0364	-.0501	-.3586
21	.0715	-.0715	.1012	.0715	-.0326	-.3586

22	.1032	-.0427	.1117	.1032	-.0020	-.3586
23	.1272	.0000	.1272	.1272	.0435	-.3586
24	.1365	.0566	.1478	.1365	.1037	-.3586
25	.1211	.1211	.1713	.1211	.1724	-.3586
26	.0733	.1771	.1917	.0733	.2319	-.3586
27	-.0000	.2000	.2000	-.0000	.2563	-.3586
28	0.0000	-.1399	.1399	0.0000	-.0836	-.2988
29	.0546	-.1319	.1428	.0546	-.0751	-.2988
30	.1073	-.1073	.1518	.1073	-.0489	-.2988
31	.1547	-.0641	.1675	.1547	-.0029	-.2988
32	.1908	.0000	.1908	.1908	.0653	-.2988
33	.2048	.0848	.2217	.2048	.1555	-.2988
34	.1817	.1817	.2569	.1817	.2586	-.2988
35	.1100	.2656	.2875	.1100	.3479	-.2988
36	-.0000	.3000	.3000	-.0000	.3845	-.2988
37	0.0000	-.1865	.1865	0.0000	-.1115	-.2391
38	.0729	-.1759	.1904	.0729	-.1002	-.2391
39	.1431	-.1431	.2023	.1431	-.0652	-.2391
40	.2063	-.0855	.2233	.2063	-.0039	-.2391
41	.2544	.0000	.2544	.2544	.0870	-.2391
42	.2731	.1131	.2956	.2731	.2074	-.2391
43	.2422	.2422	.3426	.2422	.3448	-.2391
44	.1467	.3541	.3833	.1457	.4639	-.2391
45	-.0000	.4000	.4000	-.0000	.5127	-.2391
46	0.0000	-.2332	.2332	0.0000	-.1393	-.1793
47	.0911	-.2199	.2380	.0911	-.1252	-.1793
48	.1788	-.1788	.2529	.1788	-.0816	-.1793
49	.2579	-.1068	.2791	.2579	-.0049	-.1793
50	.3180	.0000	.3180	.3160	.1088	-.1793
51	.3414	.1414	.3695	.3414	.2592	-.1793
52	.3028	.3028	.4282	.3028	.4310	-.1793
53	.1834	.4427	.4791	.1834	.5798	-.1793
54	-.0000	.5000	.5000	-.0000	.6409	-.1793
55	0.0000	-.2798	.2798	0.0000	-.1672	-.1195
56	.1093	-.2638	.2856	.1093	-.1503	-.1195
57	.2146	-.2146	.3035	.2146	-.0979	-.1195
58	.3095	-.1282	.3350	.3095	-.0059	-.1195
59	.3816	.0000	.3816	.3816	.1305	-.1195
60	.4096	.1697	.4434	.4096	.3111	-.1195
61	.3634	.3634	.5139	.3634	.5172	-.1195
62	.2200	.5312	.5759	.2200	.6958	-.1195
63	-.0000	.6000	.6000	-.0000	.7690	-.1195
64	0.0000	-.3264	.3264	0.0000	-.1951	-.0598
65	.1275	-.3078	.3332	.1275	-.1753	-.0598
66	.2504	-.2504	.3541	.2504	-.1142	-.0598
67	.3610	-.1495	.3908	.3610	-.0069	-.0598
68	.4452	.0000	.4452	.4452	.1523	-.0598
69	.4779	.1980	.5173	.4779	.3629	-.0598
70	.4239	.4239	.5995	.4239	.6034	-.0598
71	.2567	.6197	.6708	.2567	.8118	-.0598
72	-.0000	.7000	.7000	-.0000	.8972	-.0598
73	0.0000	-.3730	.3730	0.0000	-.2230	-.0000
74	.1457	-.3518	.3808	.1457	-.2003	-.0000
75	.2861	-.2861	.4047	.2861	-.1305	-.0000
76	.4126	-.1709	.4466	.4126	-.0079	-.0000
77	.5088	.0000	.5088	.5088	.1740	-.0000
78	.5462	.2262	.5912	.5462	.4148	-.0000
79	.4845	.4845	.6852	.4845	.6896	-.0000
80	.2934	.7083	.7666	.2934	.9277	-.0000
81	-.0000	.8000	.8000	-.0000	1.0254	-.0000
82	0.0000	-.4197	.4197	0.0000	-.2508	.0598
83	.1639	-.3958	.4284	.1639	-.2254	.0598
84	.3219	-.3219	.4553	.3219	-.1468	.0598
85	.4642	-.1923	.5024	.4642	-.0088	.0598
86	.5724	.0000	.5724	.5724	.1958	.0598
87	.6144	.2545	.6651	.6144	.4666	.0598

88	.5450	.5450	.7708	.5450	.7758	.0598
89	.3300	.7968	.8624	.3300	1.0437	.0598
90	-.0000	.9000	.9000	-.0000	1.1535	.0598
91	0.0000	-.4663	.4663	0.0000	-.2787	.1195
92	.1821	-.4397	.4760	.1821	-.2504	.1195
93	.3577	-.3577	.5058	.3577	-.1631	.1195
94	.5158	-.2154	.5583	.5158	-.0098	.1195
95	.6360	.0000	.6360	.6360	.2175	.1195
96	.6827	.2828	.7390	.6827	.5185	.1195
97	.6056	.6056	.8565	.6056	.8620	.1195
98	.3667	.8853	.9583	.3667	1.1597	.1195
99	-.0000	1.0000	1.0000	-.0000	1.2817	.1195

ELEMENT	1	2	3	4	XC	YC	ZC	RC	TC	AREA
1	10	11	2	1	.00607	-.03020	.03141	.03081	168.633	.6065E-03
2	11	12	3	2	.01799	-.02658	.03273	.03210	145.903	.6579E-03
3	12	13	4	3	.02912	-.01904	.03547	.03479	123.189	.7717E-03
4	13	14	5	4	.03839	-.00712	.03981	.03905	100.508	.9703E-03
5	14	15	6	5	.04396	.00943	.04583	.04496	77.897	.1284E-02
6	15	16	7	6	.04294	.02961	.05318	.05216	55.411	.1729E-02
7	16	17	8	7	.03241	.04970	.06049	.05933	33.111	.2243E-02
8	17	18	9	8	.01222	.06284	.06528	.06402	11.007	.2619E-02
9	19	20	11	10	.01417	-.07047	.07329	.07188	168.633	.1820E-02
10	20	21	12	11	.04199	-.06202	.07636	.07490	145.903	.1974E-02
11	21	22	13	12	.06794	-.04444	.08276	.08118	123.189	.2315E-02
12	22	23	14	13	.08958	-.01662	.09289	.09111	100.508	.2911E-02
13	23	24	15	14	.10257	.02199	.10694	.10490	77.897	.3853E-02
14	24	25	16	15	.10020	.06910	.12409	.12172	55.411	.5188E-02
15	25	26	17	16	.07562	.11596	.14114	.13844	33.111	.6728E-02
16	26	27	18	17	.02852	.14664	.15231	.14938	11.007	.7656E-02
17	28	29	20	19	.02307	-.11477	.11936	.11706	168.633	.3033E-02
18	29	30	21	20	.06838	-.10101	.12436	.12198	145.903	.3290E-02
19	30	31	22	21	.11064	-.07237	.13479	.13220	123.189	.3858E-02
20	31	32	23	22	.14590	-.02706	.15128	.14838	100.508	.4851E-02
21	32	33	24	23	.16704	.03582	.17416	.17084	77.897	.6422E-02
22	33	34	25	24	.16319	.11253	.20208	.19822	55.411	.8647E-02
23	34	35	26	25	.12316	.18885	.22986	.22546	33.111	.1121E-01
24	35	36	27	26	.04645	.23881	.24805	.24328	11.007	.1309E-01
25	37	38	29	28	.03209	-.15964	.16602	.16283	168.633	.4246E-02
26	38	39	30	29	.09511	-.14050	.17299	.16967	145.903	.4605E-02
27	39	40	31	30	.15390	-.10066	.18749	.18389	123.189	.5402E-02
28	40	41	32	31	.20294	-.03764	.21042	.20640	100.508	.6792E-02
29	41	42	33	32	.23235	.04982	.24226	.23763	77.897	.8990E-02
30	42	43	34	33	.22699	.15653	.28110	.27572	55.411	.1211E-01
31	43	44	35	34	.17131	.26269	.31973	.31361	33.111	.1570E-01
32	44	45	36	35	.06461	.33217	.34503	.33840	11.007	.1833E-01
33	46	47	38	37	.04115	-.20478	.21289	.20880	168.633	.5459E-02
34	47	48	39	38	.12196	-.18016	.22182	.21756	145.903	.5921E-02
35	48	49	40	39	.19734	-.12908	.24041	.23580	123.189	.6965E-02
36	49	50	41	40	.26022	-.04827	.26982	.26466	100.508	.8733E-02
37	50	51	42	41	.29794	.06389	.31064	.30471	77.897	.1156E-01
38	51	52	43	42	.29106	.20071	.36044	.35756	55.411	.1556E-01
39	52	53	44	43	.21967	.33684	.40999	.40214	33.111	.2018E-01
40	53	54	45	44	.08285	.42594	.44242	.43392	11.007	.2357E-01
41	55	56	47	46	.05023	-.24985	.25984	.25485	168.633	.6672E-02
42	56	57	48	47	.14886	-.21990	.27074	.26555	145.903	.7237E-02
43	57	58	49	48	.24086	-.15755	.29344	.28781	123.189	.8489E-02
44	58	59	50	49	.31762	-.05891	.32934	.32304	100.508	.1067E-01
45	59	60	51	50	.36365	.07798	.37916	.37192	77.897	.1413E-01
46	60	61	52	51	.35526	.24498	.43995	.43154	55.411	.1902E-01
47	61	62	53	52	.26812	.41113	.50042	.49083	33.111	.2467E-01
48	62	63	54	53	.10112	.51989	.54000	.52963	11.007	.2880E-01
49	64	65	56	55	.05931	-.29505	.30685	.30095	168.633	.7885E-02
50	65	66	57	56	.17579	-.25968	.31972	.31358	145.903	.8553E-02
51	66	67	58	57	.28443	-.18605	.34652	.33988	123.189	.1003E-01

52	67	68	59	58	.37507	-.06957	.38891	.38147	100.508	.1261E-01
53	68	69	60	59	.42943	.09289	.44775	.43920	77.897	.1670E-01
54	69	70	61	60	.41953	.28930	.51953	.50960	55.411	.2248E-01
55	70	71	62	61	.31662	.48550	.59094	.57962	33.111	.2915E-01
56	71	72	63	62	.11942	.61394	.63769	.62544	11.007	.3404E-01
57	73	74	65	64	.06841	-.34027	.35388	.34708	168.633	.9098E-02
58	74	75	66	65	.20274	-.29948	.36873	.36165	145.903	.9869E-02
59	75	76	67	66	.32883	-.21456	.39963	.39197	123.189	.1158E-01
60	76	77	68	67	.43257	-.08023	.44853	.43994	100.508	.1455E-01
61	77	78	69	68	.49526	.10620	.51638	.50652	77.897	.1926E-01
62	78	79	70	69	.48383	.33364	.59916	.58771	55.411	.2594E-01
63	79	80	71	70	.36516	.55992	.68152	.66847	33.111	.3364E-01
64	80	81	72	71	.13772	.70884	.73543	.72131	11.007	.3928E-01
65	82	83	74	73	.07750	-.38552	.40093	.39323	168.633	.1031E-01
66	83	84	75	74	.22969	-.33930	.41775	.40973	145.903	.1118E-01
67	84	85	76	75	.37165	-.24309	.45277	.44409	123.189	.1312E-01
68	85	86	77	76	.49008	-.09090	.50816	.49844	100.508	.1649E-01
69	86	87	78	77	.56111	.12032	.58504	.57386	77.897	.2183E-01
70	87	88	79	78	.54816	.37800	.67883	.66586	55.411	.2940E-01
71	88	89	80	79	.41371	.63437	.77214	.75735	33.111	.3813E-01
72	89	90	81	80	.15683	.80218	.83322	.81722	11.007	.4452E-01
73	91	92	83	82	.08660	-.43077	.44800	.43939	168.633	.1152E-01
74	92	93	84	83	.25666	-.37913	.46679	.45783	145.903	.1250E-01
75	93	94	85	84	.41528	-.27163	.50592	.49622	123.189	.1466E-01
76	94	95	86	85	.54761	-.10157	.56782	.55695	100.508	.1844E-01
77	95	96	87	86	.62698	.13445	.65372	.64123	77.897	.2440E-01
78	96	97	88	87	.61251	.42237	.75852	.74402	55.411	.3286E-01
79	97	98	89	88	.46227	.70884	.86278	.84626	33.111	.4261E-01
80	98	99	90	89	.17435	.89635	.93103	.91315	11.007	.4975E-01

STEP 1 COMPLETE.CP TIME FOR STEP IS 37.63400

STEP 2 COMPLETE.CP TIME FOR STEP IS 37.32200

STEP 3 COMPLETE.CP TIME FOR STEP IS 45.01900

STEP 2 DEPTH = .5378502 TIME = .0042107 DIMENSIONLESS TIME .3508952 WETTING FACTOR = 1.3593050

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.6865E-03	.006[illegible]	-.030202	.031410	.3249	.83	.8013E+04	.4860E+01
2	2	0	.6579E-03	.0179[illegible]	-.026581	.032727	.3249	.76	.7362E+04	.4844E+01
3	3	0	.7717E-03	.029115	-.019044	.035471	.3249	.70	.6832E+04	.5272E+01
4	4	0	.9703E-03	.038394	-.007121	.039810	.3249	.76	.7396E+04	.7176E+01
5	5	0	.1284E-02	.043958	.009426	.045833	.3249	.98	.9499E+04	.1220E+02
6	6	0	.1729E-02	.042944	.029613	.053180	.3249	1.31	.1271E+05	.2198E+02
7	7	0	.2243E-02	.032410	.049697	.060490	.3249	1.64	.1590E+05	.3566E+02
8	8	0	.2619E-02	.012224	.062844	.065275	.3249	1.84	.1787E+05	.4680E+02
9	9	0	.1820E-02	.014167	-.070471	.073289	.2903	.83	.8003E+04	.1456E+02
10	10	0	.1974E-02	.041987	-.062022	.076364	.2903	.79	.7682E+04	.1516E+02
11	11	0	.2315E-02	.067936	-.044436	.082764	.2903	.79	.7618E+04	.1764E+02
12	12	0	.2911E-02	.089585	-.016617	.092890	.2903	.88	.8544E+04	.2487E+02
13	13	0	.3853E-02	.102568	.021994	.106943	.2903	1.11	.1078E+05	.4155E+02
14	14	0	.5188E-02	.100202	.069097	.124087	.2903	1.44	.1396E+05	.7241E+02
15	15	0	.6728E-02	.075624	.115960	.141144	.2903	1.76	.1709E+05	.1150E+03
16	16	0	.7856E-02	.028522	.146636	.152309	.2903	1.96	.1904E+05	.1495E+03
17	17	0	.3033E-02	.023072	-.114767	.119356	.2522	.80	.7727E+04	.2343E+02
18	18	0	.3290E-02	.068379	-.101008	.124364	.2522	.78	.7611E+04	.2504E+02
19	19	0	.3858E-02	.110638	-.072368	.134788	.2522	.81	.7861E+04	.3033E+02
20	20	0	.4851E-02	.145895	-.027061	.151278	.2522	.94	.9090E+04	.4410E+02
21	21	0	.6422E-02	.167040	.035820	.174165	.2522	1.19	.1156E+05	.7424E+02
22	22	0	.8647E-02	.163186	.112529	.202085	.2522	1.54	.1492E+05	.1290E+03
23	23	0	.1121E-01	.123159	.188850	.229863	.2522	1.88	.1821E+05	.2042E+03
24	24	0	.1309E-01	.046450	.238807	.248846	.2522	2.09	.2027E+05	.2654E+03
25	25	0	.4246E-02	.032093	-.159638	.166021	.2135	.76	.7397E+04	.3141E+02
26	26	0	.4606E-02	.095113	-.140499	.172987	.2135	.77	.7435E+04	.3424E+02
27	27	0	.5402E-02	.153895	-.100662	.187487	.2135	.82	.7941E+04	.4290E+02

28	28	0	.6792E-02	.202937	-.037642	.210424	.2135	.98	.9459E+04	.6425E+02
29	29	0	.8990E-02	.232349	.049824	.242259	.2135	1.26	.1223E+05	.1099E+03
30	30	0	.1211E-01	.226988	.156526	.281095	.2135	1.64	.1590E+05	.1924E+03
31	31	0	.1570E-01	.171312	.262685	.319734	.2135	2.01	.1950E+05	.3061E+03
32	32	0	.1833E-01	.064611	.332175	.345026	.2135	2.24	.2177E+05	.3991E+03
33	33	0	.5459E-02	.041152	-.204701	.212886	.1747	.73	.7071E+04	.3860E+02
34	34	0	.5921E-02	.121962	-.180160	.221818	.1747	.75	.7249E+04	.4293E+02
35	35	0	.6945E-02	.197337	-.129077	.240411	.1747	.82	.7998E+04	.5555E+02
36	36	0	.8733E-02	.260223	-.048267	.269823	.1747	1.01	.9825E+04	.8580E+02
37	37	0	.1156E-01	.297937	.063889	.310645	.1747	1.34	.1296E+05	.1498E+03
38	38	0	.1556E-01	.291062	.200710	.360444	.1747	1.76	.1707E+05	.2657E+03
39	39	0	.2018E-01	.219670	.336837	.409990	.1747	2.18	.2113E+05	.4265E+03
40	40	0	.2357E-01	.082849	.425942	.442421	.1747	2.45	.2372E+05	.5590E+03
41	41	0	.6672E-02	.050229	-.249851	.259842	.1359	.70	.6760E+04	.4510E+02
42	42	0	.7237E-02	.148863	-.219897	.270744	.1359	.73	.7080E+04	.5124E+02
43	43	0	.8409E-02	.240863	-.157547	.293437	.1359	.83	.8086E+04	.6864E+02
44	44	0	.1067E-01	.317619	-.058913	.329337	.1359	1.06	.1027E+05	.1096E+03
45	45	0	.1413E-01	.363651	.077980	.379163	.1359	1.43	.1389E+05	.1962E+03
46	46	0	.1902E-01	.355261	.244980	.439945	.1359	1.92	.1862E+05	.3542E+03
47	47	0	.2467E-01	.260122	.411132	.500420	.1359	2.41	.2334E+05	.5759E+03
48	48	0	.2880E-01	.101123	.519890	.540005	.1359	2.72	.2638E+05	.7599E+03
49	49	0	.7885E-02	.059315	-.295048	.306846	.0970	.67	.6471E+04	.5102E+02
50	50	0	.8553E-02	.175792	-.259676	.319721	.0970	.72	.6942E+04	.5938E+02
51	51	0	.1003E-01	.284434	-.186847	.346519	.0970	.85	.8241E+04	.8267E+02
52	52	0	.1261E-01	.375075	-.069570	.388913	.0970	1.12	.1088E+05	.1373E+03
53	53	0	.1670E-01	.429434	.092087	.447752	.0970	1.57	.1519E+05	.2536E+03
54	54	0	.2248E-01	.419526	.289296	.519530	.0970	2.15	.2086E+05	.4690E+03
55	55	0	.2915E-01	.316625	.485504	.590944	.0970	2.74	.2662E+05	.7760E+03
56	56	0	.3404E-01	.119416	.613936	.637689	.0970	3.13	.3037E+05	.1034E+04
57	57	0	.9098E-02	.068407	-.340273	.353880	.0581	.64	.6176E+04	.5619E+02
58	58	0	.9869E-02	.202737	-.299479	.368728	.0581	.70	.6831E+04	.6741E+02
59	59	0	.1158E-01	.328033	-.214565	.399634	.0581	.88	.8517E+04	.9858E+02
60	60	0	.1455E-01	.432567	-.080234	.448526	.0581	1.22	.1185E+05	.1725E+03
61	61	0	.1926E-01	.495258	.106202	.516383	.0581	1.79	.1735E+05	.3343E+03
62	62	0	.2594E-01	.483831	.333639	.599164	.0581	2.56	.2487E+05	.6451E+03
63	63	0	.3364E-01	.365157	.559922	.681524	.0581	3.38	.3276E+05	.1102E+04
64	64	0	.3928E-01	.137720	.708041	.735435	.0581	3.92	.3891E+05	.1493E+04
65	65	0	.1031E-01	.077502	-.385516	.400932	.0191	.40	.3836E+04	.3955E+02
66	66	0	.1118E-01	.229694	-.339298	.417754	.0191	.42	.4088E+04	.4572E+02
67	67	0	.1312E-01	.371649	-.243094	.452770	.0191	.51	.4948E+04	.6491E+02
68	68	0	.1649E-01	.490082	-.090902	.508163	.0191	.75	.7312E+04	.1206E+03
69	69	0	.2183E-01	.561109	.120323	.585043	.0191	1.32	.1280E+05	.2794E+03
70	70	0	.2940E-01	.548162	.378001	.678830	.0191	2.37	.2295E+05	.6747E+03
71	71	0	.3813E-01	.413709	.634371	.772141	.0191	3.79	.3676E+05	.1402E+04
72	72	0	.4452E-01	.156031	.802183	.933220	.0191	4.93	.4781E+05	.2128E+04

FX = 0. FD = .2511962E+05 FN = .1666419E+05 SMX = .2074813E+05 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.2898635 CN = 1.5190802 MX = 1.5761389 MY = 0.0000000 MZ = 0.0000000

STEP 2 DEPTH = .5378502 TIME = .0051418 DIMENSIONLESS TIME .4284818 WETTING FACTOR = 1.1131710

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.6065E-03	.006072	-.030202	.031410	.3968	.68	.6629E+04	.4021E+01
2	2	0	.6579E-03	.017995	-.026581	.032727	.3968	.62	.5972E+04	.3929E+01
3	3	0	.7717E-03	.029115	-.019044	.035471	.3968	.56	.5429E+04	.4190E+01
4	4	0	.9703E-03	.038394	-.007121	.039810	.3968	.62	.5973E+04	.5796E+01
5	5	0	.1284E-02	.043958	.009426	.045833	.3968	.83	.8056E+04	.1034E+02
6	6	0	.1729E-02	.042944	.029613	.053180	.3968	1.16	.1123E+05	.1942E+02
7	7	0	.2243E-02	.032410	.049697	.060490	.3968	1.48	.1439E+05	.3227E+02
8	8	0	.2619E-02	.012224	.062844	.065275	.3968	1.68	.1634E+05	.4278E+02
9	9	0	.1820E-02	.014167	-.070471	.073289	.3545	.68	.6601E+04	.1201E+02
10	10	0	.1974E-02	.041987	-.062022	.076364	.3545	.65	.6264E+04	.1236E+02
11	11	0	.2315E-02	.067936	-.044436	.082764	.3545	.64	.6170E+04	.1428E+02
12	12	0	.2911E-02	.089585	-.016617	.092890	.3545	.73	.7048E+04	.2052E+02
13	13	0	.3853E-02	.102568	.021994	.106943	.3545	.95	.9224E+04	.3554E+02
14	14	0	.5188E-02	.100202	.069097	.124087	.3545	1.27	.1232E+05	.6393E+02

15	15	0	.6728E-02	.075624	.115960	.141144	.3545	1.59	.1538E+05	.1035E+03
16	16	0	.7856E-02	.028522	.146636	.152389	.3545	1.78	.1728E+05	.1358E+03
17	17	0	.3033E-02	.023072	-.114767	.119356	.3079	.65	.6280E+04	.1904E+02
18	18	0	.3290E-02	.068379	-.101008	.124364	.3079	.63	.6137E+04	.2019E+02
19	19	0	.3858E-02	.110638	-.072368	.134788	.3079	.65	.6333E+04	.2444E+02
20	20	0	.4851E-02	.145895	-.027051	.151278	.3079	.77	.7479E+04	.3629E+02
21	21	0	.6422E-02	.167040	.035820	.174165	.3079	1.01	.9840E+04	.6319E+02
22	22	0	.8647E-02	.163186	.112529	.202085	.3079	1.35	.1307E+05	.1130E+03
23	23	0	.1121E-01	.123159	.188850	.229863	.3079	1.67	.1624E+05	.1821E+03
24	24	0	.1309E-01	.046456	.238807	.248046	.3079	1.88	.1822E+05	.2385E+03
25	25	0	.4246E-02	.032093	-.159638	.166021	.2607	.61	.5874E+04	.2494E+02
26	26	0	.4606E-02	.095113	-.140499	.172987	.2607	.61	.5872E+04	.2704E+02
27	27	0	.5402E-02	.153895	-.100662	.187487	.2607	.65	.6296E+04	.3401E+02
28	28	0	.6792E-02	.202937	-.037642	.210424	.2607	.79	.7687E+04	.5221E+02
29	29	0	.8990E-02	.232349	.049824	.242259	.2607	1.06	.1029E+05	.9249E+02
30	30	0	.1211E-01	.226988	.156526	.281695	.2607	1.42	.1376E+05	.1666E+03
31	31	0	.1578E-01	.171312	.262685	.319734	.2607	1.77	.1718E+05	.2697E+03
32	32	0	.1833E-01	.064611	.332175	.345026	.2607	1.99	.1934E+05	.3545E+03
33	33	0	.5459E-02	.041152	-.204701	.212886	.2134	.56	.5432E+04	.2965E+02
34	34	0	.5921E-02	.121962	-.180160	.221818	.2134	.57	.5550E+04	.3287E+02
35	35	0	.6945E-02	.197337	-.129077	.240411	.2134	.64	.6179E+04	.4291E+02
36	36	0	.8733E-02	.260223	-.049267	.269823	.2134	.81	.7822E+04	.6831E+02
37	37	0	.1156E-01	.297937	.063889	.316645	.2134	1.10	.1072E+05	.1239E+03
38	38	0	.1556E-01	.291062	.200710	.360444	.2134	1.50	.1455E+05	.2265E+03
39	39	0	.2018E-01	.219670	.336837	.409990	.2134	1.89	.1835E+05	.3704E+03
40	40	0	.2357E-01	.082849	.425942	.442421	.2134	2.14	.2078E+05	.4897E+03
41	41	0	.6672E-02	.050229	-.249851	.259842	.1659	.51	.4938E+04	.3294E+02
42	42	0	.7237E-02	.148863	-.219897	.270744	.1659	.53	.5171E+04	.3742E+02
43	43	0	.8489E-02	.240863	-.157547	.293437	.1659	.62	.6001E+04	.5094E+02
44	44	0	.1067E-01	.317619	-.058913	.329337	.1659	.82	.7922E+04	.8455E+02
45	45	0	.1413E-01	.363651	.077980	.379163	.1659	1.15	.1120E+05	.1582E+03
46	46	0	.1902E-01	.355261	.244980	.439945	.1659	1.60	.1554E+05	.2957E+03
47	47	0	.2467E-01	.268122	.411132	.500420	.1659	2.05	.1991E+05	.4912E+03
48	48	0	.2883E-01	.101123	.519890	.540005	.1659	2.34	.2273E+05	.6547E+03
49	49	0	.7885E-02	.059315	-.295048	.306846	.1184	.45	.4339E+04	.3421E+02
50	50	0	.8553E-02	.175792	-.259676	.319721	.1184	.48	.4680E+04	.4003E+02
51	51	0	.1003E-01	.284434	-.186047	.346519	.1184	.59	.5717E+04	.5735E+02
52	52	0	.1261E-01	.375075	-.069570	.388913	.1184	.82	.7969E+04	.1005E+03
53	53	0	.1670E-01	.429434	.092087	.447752	.1184	1.21	.1178E+05	.1967E+03
54	54	0	.2248E-01	.419526	.289296	.519530	.1184	1.74	.1690E+05	.3800E+03
55	55	0	.2915E-01	.316625	.485504	.590944	.1184	2.28	.2216E+05	.6460E+03
56	56	0	.3404E-01	.119416	.613936	.637589	.1184	2.64	.2561E+05	.8717E+03
57	57	0	.9098E-02	.068407	-.340273	.353880	.0709	.35	.3423E+04	.3114E+02
58	58	0	.9869E-02	.202737	-.299479	.368726	.0709	.40	.3857E+04	.3807E+02
59	59	0	.1158E-01	.328033	-.214565	.399634	.0709	.53	.5105E+04	.5909E+02
60	60	0	.1455E-01	.432567	-.080234	.448526	.0709	.80	.7792E+04	.1134E+03
61	61	0	.1926E-01	.495258	.106202	.516383	.0709	1.29	.1248E+05	.2404E+03
62	62	0	.2554E-01	.483831	.333639	.599164	.0709	1.97	.1909E+05	.4952E+03
63	63	0	.3364E-01	.365157	.559922	.681524	.0709	2.70	.2618E+05	.8806E+03
64	64	0	.3928E-01	.137720	.708041	.735435	.0709	3.19	.3095E+05	.1216E+04
65	65	0	.1031E-01	.077502	-.385516	.400932	.0233	0.00	0.	0.
66	66	0	.1118E-01	.229694	-.339298	.417754	.0233	0.00	0.	0.
67	67	0	.1312E-01	.371649	-.243094	.452770	.0233	0.00	0.	0.
68	68	0	.1649E-01	.490082	-.090902	.508163	.0233	0.00	0.	0.
69	69	0	.2183E-01	.561109	.120323	.585043	.0233	.33	.3199E+04	.6985E+02
70	70	0	.2940E-01	.548162	.378001	.678030	.0233	1.16	.1123E+05	.3302E+03
71	71	0	.3813E-01	.413709	.634371	.772141	.0233	2.38	.2307E+05	.8797E+03
72	72	0	.4452E-01	.156031	.802183	.833220	.0233	3.39	.3290E+05	.1465E+04

FX = 0. FD = .1900820E+05 FN = .1329214E+05 SMX = .1598109E+05 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.7327569 CN = 1.2116900 MX = 1.2140003 MY = 0.0000000 MZ = 0.0000000

EXAMPLE 3

*******PROGRAM OPTIONS*******
VARIABLE BODY ORIENTATION
DONT PRINT
SYMMETRIC CONFIGURATION

*******PROBLEM PARAMETERS*******
DIAMETER 1.0000 FT
ENTRY VELOCITY 50.000(FT/SEC)
BODY ORIENTATION ANGLE 90.00 DEGREES
INITIAL DEPTH 0.00000 FT TERMINATION STEP 18
INITIAL PRESSURE CORRECTION FACTOR = .6760
CENTROIDE COORDINATES 0.00000 0.00000 0.00000

NO	VX	VY	VZ	WX	CWT	H
1	0.0000	0.0000	-50.0000	0.0	1.262200	.050001
2	0.0000	0.0000	-50.0000	0.0	1.252000	.050000
3	0.0000	0.0000	-50.0000	0.0	1.232900	.050000
4	0.0000	0.0000	-50.0000	0.0	1.224200	.050000
5	0.0000	0.0000	-50.0000	0.0	1.207500	.050000
6	0.0000	0.0000	-50.0000	0.0	1.199500	.050000
7	0.0000	0.0000	-50.0000	0.0	1.183000	.050000
8	0.0000	0.0000	-50.0000	0.0	1.176100	.050000
9	0.0000	0.0000	-50.0000	0.0	1.160700	.050000
10	0.0000	0.0000	-50.0000	0.0	1.153000	.050000
11	0.0000	0.0000	-50.0000	0.0	1.137700	.050000
12	0.0000	0.0000	-50.0000	0.0	1.130600	.050000
13	0.0000	0.0000	-50.0000	0.0	1.114100	.050000
14	0.0000	0.0000	-50.0000	0.0	[illegible]	.050000
15	0.0000	0.0000	-50.0000	0.0	1.089500	.050000
16	0.0000	0.0000	-50.0000	0.0	1.081100	.050000
17	0.0000	0.0000	-50.0000	0.0	1.067100	.050000
18	0.0000	0.0000	-50.0000	0.0	1.061500	.050000

*******GRID OPTIONS*******
STANDARD

GRID SIZE

R	Z	NUMBER
.000100	0.000000	8
.112400	.100000	8
.203500	.200000	8
.278500	.300000	8
.340400	.400000	6
.391300	.500000	6
.432300	.600000	6
.464500	.700000	8
.488500	.800000	8
.500000	.870000	8

NODE	X	Y	Z	XP	YP	ZP
1	0.0000	-.0001	0.0000	0.0000	-.0001	-.0000
2	.0001	-.0000	0.0000	.0001	-.0009	-.0006
3	.0001	.0001	0.0000	.0001	.0001	.0006
4	-.0006	.0001	0.0000	-.0000	.0001	.0000
5	0.0000	-.0001	0.0000	0.0000	-.0001	-.0000
6	.0000	-.0001	0.0000	.0000	-.0001	-.0000
7	.0001	-.0001	0.0000	.0001	-.0001	-.0000
8	.0001	-.0000	0.0000	.0001	-.0006	-.0006
9	.0001	.0000	0.0006	.0001	.0006	.0000
10	.0001	.0000	0.0000	.0001	.0000	.0000
11	.0001	.0001	0.0000	.0001	.0001	.0000
12						

13	-.0000	.0001	0.0000	-.0000	.0001	.0000
14	0.0000	-.1124	.1000	0.0000	-.1124	.1000
15	.0430	-.1038	.1000	.0430	-.1038	.1000
16	.0795	-.0795	.1000	.0795	-.0795	.1000
17	.1038	-.0430	.1000	.1038	-.0430	.1000
18	.1124	.0000	.1000	.1124	.0000	.1000
19	.1038	.0430	.1000	.1038	.0430	.1000
20	.0795	.0795	.1000	.0795	.0795	.1000
21	.0430	.1038	.1000	.0430	.1038	.1000
22	-.0000	.1124	.1000	-.0000	.1124	.1000
23	0.0000	-.2035	.2000	0.0000	-.2035	.2000
24	.0779	-.1880	.2000	.0779	-.1880	.2000
25	.1439	-.1439	.2000	.1439	-.1439	.2000
26	.1880	-.0779	.2000	.1880	-.0779	.2000
27	.2035	.0000	.2000	.2035	.0000	.2000
28	.1880	.0779	.2000	.1880	.0779	.2000
29	.1439	.1439	.2000	.1439	.1439	.2000
30	.0779	.1880	.2000	.0779	.1880	.2000
31	-.0000	.2035	.2000	-.0000	.2035	.2000
32	0.0000	-.2785	.3000	0.0000	-.2785	.3000
33	.1066	-.2573	.3000	.1066	-.2573	.3000
34	.1969	-.1969	.3000	.1969	-.1969	.3000
35	.2573	-.1066	.3000	.2573	-.1066	.3000
36	.2785	.0000	.3000	.2785	-.0000	.3000
37	.2573	.1066	.3000	.2573	.1066	.3000
38	.1969	.1969	.3000	.1969	.1969	.3000
39	.1066	.2573	.3000	.1066	.2573	.3000
40	-.0000	.2785	.3000	-.0000	.2785	.3000
41	0.0000	-.3404	.4000	0.0000	-.3404	.4000
42	.1303	-.3145	.4000	.1303	-.3145	.4000
43	.2407	-.2407	.4000	.2407	-.2407	.4000
44	.3145	-.1303	.4000	.3145	-.1303	.4000
45	.3404	.0000	.4000	.3404	-.0000	.4000
46	.3145	.1303	.4000	.3145	.1303	.4000
47	.2407	.2407	.4000	.2407	.2407	.4000
48	.1303	.3145	.4000	.1303	.3145	.4000
49	-.0000	.3404	.4000	-.0000	.3404	.4000
50	0.0000	-.3913	.5000	0.0000	-.3913	.5000
51	.1497	-.3615	.5000	.1497	-.3615	.5000
52	.2767	-.2767	.5000	.2767	-.2767	.5000
53	.3615	-.1497	.5000	.3615	-.1497	.5000
54	.3913	.0000	.5000	.3913	-.0000	.5000
55	.3615	.1497	.5000	.3615	.1497	.5000
56	.2767	.2767	.5000	.2767	.2767	.5000
57	.1497	.3615	.5000	.1497	.3615	.5000
58	-.0000	.3913	.5000	-.0000	.3913	.5000
59	0.0000	-.4323	.6000	0.0000	-.4323	.6000
60	.1654	-.3994	.6000	.1654	-.3994	.6000
61	.3057	-.3057	.6000	.3057	-.3057	.6000
62	.3994	-.1654	.6000	.3994	-.1654	.6000
63	.4323	.0000	.6000	.4323	-.0000	.6000
64	.3994	.1654	.6000	.3994	.1654	.6000
65	.3057	.3057	.6000	.3057	.3057	.6000
66	.1654	.3994	.6000	.1654	.3994	.6000
67	-.0000	.4323	.6000	-.0000	.4323	.6000
68	0.0000	-.4645	.7000	0.0000	-.4645	.7000
69	.1778	-.4291	.7000	.1778	-.4291	.7000
70	.3285	-.3285	.7000	.3285	-.3285	.7000
71	.4291	-.1778	.7000	.4291	-.1778	.7000
72	.4645	.0000	.7000	.4645	-.0000	.7000
73	.4291	.1778	.7000	.4291	.1778	.7000
74	.3285	.3285	.7000	.3285	.3285	.7000
75	.1778	.4291	.7000	.1778	.4291	.7000
76	-.0000	.4645	.7000	-.0000	.4645	.7000
77	0.0000	-.4885	.8000	0.0000	-.4885	.8000
78	.1869	-.4513	.8000	.1869	-.4513	.8000

79	.3454	-.3454	.8000	.3454	-.3454	.0000
80	.4513	-.1869	.8000	.4513	-.1869	.8000
81	.4885	.0000	.8000	.4885	-.0000	.8000
82	.4513	.1869	.8000	.4513	.1869	.8000
83	.3454	.3454	.8000	.3454	.3454	.8000
84	.1869	.4513	.8000	.1869	.4513	.8000
85	-.0000	.4885	.8000	-.0000	.4885	.8000
86	0.0000	-.5000	.8700	0.0000	-.5000	.8700
87	.1913	-.4619	.8700	.1913	-.4619	.8700
88	.3536	-.3536	.8700	.3536	-.3536	.8700
89	.4619	-.1913	.8700	.4619	-.1913	.8700
90	.5000	.0000	.8700	.5000	-.0000	.8700
91	.4619	.1913	.8700	.4619	.1913	.8700
92	.3536	.3536	.8700	.3536	.3536	.8700
93	.1913	.4619	.8700	.1913	.4619	.8700
94	-.0000	.5000	.8700	-.0000	.5000	.8700

ELEMENT	1	2	3	4	XC	YC	ZC	RC	TC	AREA
1	14	15	6	5	.01434	-.07208	.06664	.07349	168.750	.3265E-02
2	15	16	7	6	.04083	-.06111	.06664	.07349	146.250	.3265E-02
3	16	17	8	7	.06111	-.04083	.06664	.07349	123.750	.3265E-02
4	17	18	9	8	.07208	-.01434	.06664	.07349	101.250	.3265E-02
5	18	19	10	9	.07208	.01434	.06664	.07349	78.750	.3265E-02
6	19	20	11	10	.06111	.04083	.06664	.07349	56.250	.3265E-02
7	20	21	12	11	.04083	.06111	.06664	.07349	33.750	.3265E-02
8	21	22	13	12	.01434	.07208	.06664	.07349	11.250	.3265E-02
9	23	24	15	14	.03106	-.15615	.15481	.15921	168.750	.8265E-02
10	24	25	16	15	.08845	-.13238	.15481	.15921	146.250	.8265E-02
11	25	26	17	16	.13238	-.08845	.15481	.15921	123.750	.8265E-02
12	26	27	18	17	.15615	-.03106	.15481	.15921	101.250	.8265E-02
13	27	28	19	18	.15615	.03106	.15481	.15921	78.750	.8265E-02
14	28	29	20	19	.13238	.08845	.15481	.15921	56.250	.8265E-02
15	29	30	21	20	.08845	.13238	.15481	.15921	33.750	.8265E-02
16	30	31	22	21	.03106	.15615	.15481	.15921	11.250	.8265E-02
17	32	33	24	23	.04649	-.23370	.25259	.23828	168.750	.1167E-01
18	33	34	25	24	.13238	-.19812	.25259	.23828	146.250	.1167E-01
19	34	35	26	25	.19812	-.13238	.25259	.23828	123.750	.1167E-01
20	35	36	27	26	.23370	-.04649	.25259	.23828	101.250	.1167E-01
21	36	37	28	27	.23370	.04649	.25259	.23828	78.750	.1167E-01
22	37	38	29	28	.19812	.13238	.25259	.23828	56.250	.1167E-01
23	38	39	30	29	.13238	.19812	.25259	.23828	33.750	.1167E-01
24	39	40	31	30	.04649	.23370	.25259	.23828	11.250	.1167E-01
25	41	42	33	32	.05941	-.29866	.35167	.30452	168.750	.1413E-01
26	42	43	34	33	.16918	-.25320	.35167	.30452	146.250	.1413E-01
27	43	44	35	34	.25320	-.16918	.35167	.30452	123.750	.1413E-01
28	44	45	36	35	.29866	-.05941	.35167	.30452	101.250	.1413E-01
29	45	46	37	36	.29866	.05941	.35167	.30452	78.750	.1413E-01
30	46	47	38	37	.25320	.16918	.35167	.30452	56.250	.1413E-01
31	47	48	39	38	.16918	.25320	.35157	.30452	33.750	.1413E-01
32	48	49	40	39	.05941	.29866	.35167	.30452	11.250	.1413E-01
33	50	51	42	41	.07012	-.35249	.45116	.35940	168.750	.1595E-01
34	51	52	43	42	.19967	-.29883	.45116	.35940	146.250	.1595E-01
35	52	53	44	43	.29883	-.19967	.45116	.35940	123.750	.1595E-01
36	53	54	45	44	.35249	-.07012	.45116	.35940	101.250	.1595E-01
37	54	55	46	45	.35249	.07012	.45116	.35940	78.750	.1595E-01
38	55	56	47	46	.29883	.19967	.45116	.35940	56.250	.1595E-01
39	56	57	48	47	.19967	.29883	.45116	.35940	33.750	.1595E-01
40	57	58	49	48	.07012	.35249	.45116	.35940	11.250	.1595E-01
41	59	60	51	50	.07886	-.39645	.55083	.40422	168.750	.1732E-01
42	60	61	52	51	.22457	-.33610	.55083	.40422	146.250	.1732E-01
43	61	62	53	52	.33610	-.22457	.55083	.40422	123.750	.1732E-01
44	62	63	54	53	.39645	-.07886	.55083	.40422	101.250	.1732E-01
45	63	64	55	54	.39645	.07886	.55083	.40422	78.750	.1732E-01
46	64	65	56	55	.33610	.22457	.55083	.40422	56.250	.1732E-01
47	65	66	57	56	.22457	.33610	.55083	.40422	33.750	.1732E-01

48	66	67	58	57	.07886	.39645	.55083	.40422	11.250	.1732E-01
49	68	69	60	59	.08583	-.43152	.65060	.43997	166.750	.1835E-01
50	69	70	61	60	.24444	-.36582	.65060	.43997	146.250	.1835E-01
51	70	71	62	61	.36582	-.24444	.65060	.43997	123.750	.1835E-01
52	71	72	63	62	.43152	-.08583	.65060	.43997	101.250	.1835E-01
53	72	73	64	63	.43152	.08583	.65060	.43997	78.750	.1835E-01
54	73	74	65	64	.36582	.24444	.65060	.43997	56.250	.1835E-01
55	74	75	66	65	.24444	.36582	.65060	.43997	33.750	.1835E-01
56	75	76	67	66	.08583	.43152	.65060	.43997	11.250	.1835E-01
57	77	78	69	68	.09119	-.45846	.75042	.46744	168.750	.1910E-01
58	78	79	70	69	.25970	-.38866	.75042	.46744	146.250	.1910E-01
59	79	80	71	70	.38866	-.25970	.75042	.46744	123.750	.1910E-01
60	80	81	72	71	.45846	-.09119	.75042	.46744	101.250	.1910E-01
61	81	82	73	72	.45846	.09119	.75042	.46744	78.750	.1910E-01
62	82	83	74	73	.38866	.25970	.75042	.46744	56.250	.1910E-01
63	83	84	75	74	.25970	.38866	.75042	.46744	33.750	.1910E-01
64	84	85	76	75	.09119	.45846	.75042	.46744	11.250	.1910E-01
65	86	87	78	77	.09457	-.47546	.83514	.48477	168.750	.1367E-01
66	87	88	79	78	.26933	-.40308	.83514	.48477	146.250	.1367E-01
67	88	89	80	79	.40308	-.26933	.83514	.48477	123.750	.1367E-01
68	89	90	81	80	.47546	-.09457	.83514	.48477	101.250	.1367E-01
69	90	91	82	81	.47546	.09457	.83514	.48477	78.750	.1367E-01
70	91	92	83	82	.40308	.26933	.83514	.48477	56.250	.1367E-01
71	92	93	84	83	.26933	.40308	.83514	.48477	33.750	.1367E-01
72	93	94	85	84	.09457	.47546	.83514	.48477	11.250	.1367E-01

STEP 1 COMPLETE.CP TIME FOR STEP IS 1.23300

STEP 2 COMPLETE.CP TIME FOR STEP IS 1.33900

STEP 3 COMPLETE.CP TIME FOR STEP IS 3.72800

STEP 4 COMPLETE.CP TIME FOR STEP IS 4.10600

STEP 5 COMPLETE.CP TIME FOR STEP IS 7.19100

STEP 6 COMPLETE.CP TIME FOR STEP IS 6.76600

STEP 7 COMPLETE.CP TIME FOR STEP IS 9.97300

STEP 8 COMPLETE.CP TIME FOR STEP IS 9.79300

STEP 9 COMPLETE.CP TIME FOR STEP IS 13.20100

STEP 10 COMPLETE.CP TIME FOR STEP IS 12.79700

STEP 11 COMPLETE.CP TIME FOR STEP IS 16.56500

STEP 12 COMPLETE.CP TIME FOR STEP IS 16.00300

STEP 13 COMPLETE.CP TIME FOR STEP IS 19.98400

STEP 14 COMPLETE.CP TIME FOR STEP IS 26.17900

STEP 15 COMPLETE.CP TIME FOR STEP IS 24.38400

STEP 16 COMPLETE.CP TIME FOR STEP IS 24.06500

STEP 17 COMPLETE.CP TIME FOR STEP IS 28.82900

STEP 18 COMPLETE.CP TIME FOR STEP IS 28.16300

STEP 1 DEPTH = .0560010 TIME = .0007923 DIMENSIONLESS TIME .0396142 WETTING FACTORS = 1.2622000 1.2520000
AVERAGE VELOCITY 0.000 0.000 -50.000 WE 0.000RIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	1	.8177E-03	.007175	-.036874	.033304	.0132	1.78	.4326E+04	.3538E+01
2	2	1	.8177E-03	.020434	-.030582	.033304	.0132	1.78	.4326E+04	.3538E+01
3	3	1	.8177E-03	.030582	-.020434	.033304	.0132	1.78	.4326E+04	.3538E+01
4	4	1	.8177E-03	.036874	-.007175	.033304	.0132	1.78	.4326E+04	.3538E+01
5	5	1	.8177E-03	.036874	.007175	.033304	.0132	1.78	.4326E+04	.3538E+01
6	6	1	.8177E-03	.030582	.020434	.033304	.0132	1.78	.4326E+04	.3538E+01
7	7	1	.8177E-03	.020434	.030582	.033304	.0132	1.78	.4326E+04	.3538E+01
8	8	1	.8177E-03	.007175	.036874	.033304	.0132	1.78	.4326E+04	.3538E+01

FX = 0. FD = .4198940E+02 FN = .2753865F-08 SMX = -.1917897F-09 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .0220656 CN = .0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 2 DEPTH = .1600010 TIME = .0015910 DIMENSIONLESS TIME .0795503 WETTING FACTORS = 1.2520000 1.2329060
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.0265	2.17	.5264E+04	.1719E+02
2	2	0	.3265E-02	.040831	-.061108	.066637	.0265	2.17	.5264E+04	.1719E+02
3	3	0	.3265E-02	.061108	-.040831	.066637	.0265	2.17	.5264E+04	.1719E+02
4	4	0	.3265E-02	.072081	-.014338	.066637	.0265	2.17	.5264E+04	.1719E+02
5	5	0	.3265E-02	.072081	.014338	.066637	.0265	2.17	.5264E+04	.1719E+02
6	6	0	.3265E-02	.061108	.040831	.066637	.0265	2.17	.5264E+04	.1719E+02
7	7	0	.3265E-02	.040831	.061108	.066637	.0265	2.17	.5264E+04	.1719E+02
8	8	0	.3265E-02	.014338	.072081	.066637	.0265	2.17	.5264E+04	.1719E+02

FX = 0. FD = .2035190E+03 FN = .3667064F-07 SMX = .3168473F-08 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .1069147 CN = .0000000 MX = .0000000 MY = 0.0000000 MZ = 0.0000000

STEP 3 DEPTH = .1500010 TIME = .0024021 DIMENSIONLESS TIME .1201051 WETTING FACTORS = 1.2329000 1.2242000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX . 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.0671	1.27	.3072E+04	.1003E+02
2	2	0	.3265E-02	.040831	-.061108	.066637	.0671	1.27	.3072E+04	.1003E+02
3	3	0	.3265E-02	.061108	-.040831	.066637	.0671	1.27	.3072E+04	.1003E+02
4	4	0	.3265E-02	.072081	-.014338	.066637	.0671	1.27	.3072E+04	.1003E+02
5	5	0	.3265E-02	.072081	.014338	.066637	.0671	1.27	.3072E+04	.1003E+02
6	6	0	.3265E-02	.061108	.040831	.066637	.0671	1.27	.3072E+04	.1003E+02
7	7	0	.3265E-02	.040831	.061108	.066637	.0671	1.27	.3072E+04	.1003E+02
8	8	0	.3265E-02	.014338	.072081	.066637	.0671	1.27	.3072E+04	.1003E+02
9	9	1	.3537E-02	.026109	-.131261	.126405	.0191	1.20	.2906E+04	.1028E+02
10	10	1	.3537E-02	.074353	-.111278	.126405	.0191	1.20	.2906E+04	.1028E+02
11	11	1	.3537E-02	.111278	-.074353	.126405	.0191	1.20	.2906E+04	.1028E+02
12	12	1	.3537E-02	.131261	-.026109	.126405	.0191	1.20	.2906E+04	.1028E+02
13	13	1	.3537E-02	.131261	.026109	.126405	.0191	1.20	.2906E+04	.1028E+02
14	14	1	.3537E-02	.111278	.074353	.126405	.0191	1.20	.2906E+04	.1028E+02
15	15	1	.3537E-02	.074353	.111278	.126405	.0191	1.20	.2906E+04	.1028E+02
16	16	1	.3537E-02	.026109	.131261	.126405	.0191	1.20	.2906E+04	.1028E+02

FX = 0. FD = .2283642E+03 FN = -.8061290E-09 SMX = -.5660864F-06 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .1199698 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 4 DEPTH = .2000010 TIME = .0032190 DIMENSIONLESS TIME .1609+01 WETTING FACTORS = 1.2242000 1.2075000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072051	.066637	.1074	1.21	.2926E+04	.9554E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.1073	1.21	.2926E+04	.9554E+01

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
3	3	0	.3265E-02	.061108	-.040831	.066637	.1079	1.21	.2926E+04	.9554E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.1079	1.21	.2926E+04	.9554E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.1079	1.21	.2926E+04	.9554E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.1079	1.21	.2926E+04	.9554E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.1079	1.21	.2926E+04	.9554E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.1079	1.21	.2926E+04	.9554E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.0368	1.18	.2868E+04	.2371E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.0368	1.18	.2868E+04	.2371E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.0368	1.18	.2868E+04	.2371E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.0368	1.18	.2868E+04	.2371E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.0368	1.18	.2868E+04	.2371E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.0368	1.18	.2868E+04	.2371E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.0368	1.18	.2868E+04	.2371E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.0368	1.18	.2868E+04	.2371E+02

FX = 0. FD = .3658917E+03 FN = .3926015E-07 SMX = .2327482E-08 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .1921196 CN = .0000000 MX = .0000000 MY = 0.0000000 MZ = 0.0000000

STEP 5 DEPTH = .2500010 TIME = .0040471 DIMENSIONLESS TIME .2023559 WETTING FACTORS = 1.2075000 1.1995000
AVERAGE VELOCITY 0.000 0.000 -90.000 WX 0.000 ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.1493	1.10	.2669E+04	.8715E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.1493	1.10	.2669E+04	.8715E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.1493	1.10	.2669E+04	.8715E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.1493	1.10	.2669E+04	.8715E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.1493	1.10	.2669E+04	.8715E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.1493	1.10	.2669E+04	.8715E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.1493	1.10	.2669E+04	.8715E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.1493	1.10	.2669E+04	.8715E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.0782	.95	.2294E+04	.1896E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.0782	.95	.2294E+04	.1896E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.0782	.95	.2294E+04	.1896E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.0782	.95	.2294E+04	.1896E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.0782	.95	.2294E+04	.1896E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.0782	.95	.2294E+04	.1896E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.0782	.95	.2294E+04	.1896E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.0782	.95	.2294E+04	.1896E+02
17	17	1	.5383E-02	.042627	-.214299	.225704	.0201	.79	.1905E+04	.1026E+02
18	18	1	.5383E-02	.121390	-.181674	.225704	.0201	.79	.1905E+04	.1026E+02
19	19	1	.5383E-02	.181674	-.121390	.225704	.0201	.79	.1905E+04	.1026E+02
20	20	1	.5383E-02	.214299	-.042627	.225704	.0201	.79	.1905E+04	.1026E+02
21	21	1	.5383E-02	.214299	.042627	.225704	.0201	.79	.1905E+04	.1026E+02
22	22	1	.5383E-02	.181674	.121390	.225704	.0201	.79	.1905E+04	.1026E+02
23	23	1	.5383E-02	.121390	.181674	.225704	.0201	.79	.1905E+04	.1026E+02
24	24	1	.5383E-02	.042627	.214299	.225704	.0201	.79	.1905E+04	.1026E+02

FX = 0. FD = .4026207E+03 FN = -.1655361E-07 SMX = -.1957196E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2114049 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 6 DEPTH = .3000010 TIME = .048608 DIMENSIONLESS TIME .2440400 WETTING FACTORS = 1.1995000 1.1838000
AVERAGE VELOCITY 0.000 0.000 -90.000 WX 0.000 ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.1910	1.07	.2607E+04	.8510E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.1910	1.07	.2607E+04	.8510E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.1910	1.07	.2607E+04	.8510E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.1910	1.07	.2607E+04	.8510E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.1910	1.07	.2607E+04	.8510E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.1910	1.07	.2607E+04	.8510E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.1910	1.07	.2607E+04	.8510E+01
8	8	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

9	9	0	.8265E-02	.031060	-.156150	.154806	.1199	.89	.2166E+04	.1790E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.1199	.89	.2166E+04	.1790E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.1199	.89	.2166E+04	.1790E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.1199	.89	.2166E+04	.1790E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.1199	.89	.2166E+04	.1790E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.1199	.89	.2166E+04	.1790E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.1199	.89	.2166E+04	.1790E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.1199	.89	.2166E+04	.1790E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.0394	.71	.1714E+04	.2001E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.0394	.71	.1714E+04	.2001E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.0394	.71	.1714E+04	.2001E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.0394	.71	.1714E+04	.2001E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.0394	.71	.1714E+04	.2001E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.0394	.71	.1714E+04	.2001E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.0394	.71	.1714E+04	.2001E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.0394	.71	.1714E+04	.2001E+02

FX = 0. FD = .4813580E+03 FN = .1800777E-07 SMX = -.9190359E-08 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2527477 CN = .0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 7 DEPTH = .3500013 TIME = .0057255 DIMENSIONLESS TIME .2862760 WETTING FACTORS = 1.1838000 1.1761000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOC	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.2333	1.03	.2493E+04	.8140E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.2333	1.03	.2493E+04	.8140E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.2333	1.03	.2493E+04	.8140E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.2333	1.03	.2493E+04	.8140E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.2333	1.03	.2493E+04	.8140E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.2333	1.03	.2493E+04	.8140E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.2333	1.03	.2493E+04	.8140E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.2333	1.03	.2493E+04	.8140E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.1621	.81	.1968E+04	.1627E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.1621	.81	.1968E+04	.1627E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.1621	.81	.1968E+04	.1627E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.1621	.81	.1968E+04	.1627E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.1621	.81	.1968E+04	.1627E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.1621	.81	.1968E+04	.1627E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.1621	.81	.1968E+04	.1627E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.1621	.81	.1968E+04	.1627E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.0816	.65	.1577E+04	.1841E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.0816	.65	.1577E+04	.1841E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.0816	.65	.1577E+04	.1841E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.0816	.65	.1577E+04	.1841E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.0816	.65	.1577E+04	.1841E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.0816	.65	.1577E+04	.1841E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.0816	.65	.1577E+04	.1841E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.0816	.65	.1577E+04	.1841E+02
25	25	1	.6709E-02	.056302	-.283048	.325439	.0207	.44	.1072E+04	.7194E+01
26	26	1	.6709E-02	.160334	-.239956	.325439	.0207	.44	.1072E+04	.7194E+01
27	27	1	.6709E-02	.239956	-.160334	.325439	.0207	.44	.1072E+04	.7194E+01
28	28	1	.6709E-02	.283048	-.056302	.325439	.0207	.44	.1072E+04	.7194E+01
29	29	1	.6709E-02	.283048	.056302	.325439	.0207	.44	.1072E+04	.7194E+01
30	30	1	.6709E-02	.239956	.160334	.325439	.0207	.44	.1072E+04	.7194E+01
31	31	1	.6709E-02	.160334	.239956	.325439	.0207	.44	.1072E+04	.7194E+01
32	32	1	.6709E-02	.056302	.283048	.325439	.0207	.44	.1072E+04	.7194E+01

FX = 0. FD = .5040894E+03 FN = -.4845934E-07 SMX = -.3900821E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2644786 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 8 DEPTH = .4000010 TIME = .0065758 DIMENSIONLESS TIME .3287402 WETTING FACTORS = 1.1761000 1.1607000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.2758	1.00	.2428E+04	.7928E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.2758	1.00	.2428E+04	.7928E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.2758	1.00	.2428E+04	.7928E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.2758	1.00	.2428E+04	.7928E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.2758	1.00	.2428E+04	.7928E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.2758	1.00	.2428E+04	.7928E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.2758	1.00	.2428E+04	.7928E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.2758	1.00	.2428E+04	.7928E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.2046	.79	.1904E+04	.1573E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.2046	.79	.1904E+04	.1573E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.2046	.79	.1904E+04	.1573E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.2046	.79	.1904E+04	.1573E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.2046	.79	.1904E+04	.1573E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.2046	.79	.1904E+04	.1573E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.2046	.79	.1904E+04	.1573E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.2046	.79	.1904E+04	.1573E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.1241	.61	.1488E+04	.1737E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.1241	.61	.1488E+04	.1737E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.1241	.61	.1488E+04	.1737E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.1241	.61	.1488E+04	.1737E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.1241	.61	.1488E+04	.1737E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.1241	.61	.1488E+04	.1737E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.1241	.61	.1488E+04	.1737E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.1241	.61	.1488E+04	.1737E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.0410	.35	.8571E+03	.1211E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.0410	.35	.8571E+03	.1211E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.0410	.35	.8571E+03	.1211E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.0410	.35	.8571E+03	.1211E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.0410	.35	.8571E+03	.1211E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.0410	.35	.8571E+03	.1211E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.0410	.35	.8571E+03	.1211E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.0410	.35	.8571E+03	.1211E+02

FX = 0. FD = .5768074E+03 FN = -.2329455E-07 SMX = -.3351587E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2766119 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 0 DEPTH = .4500010 TIME = .0074374 DIMENSIONLESS TIME .3718677 WETTING FACTORS = 1.1607000 1.1530000
AVERAGE VELOCITY 0.000 0.000 -56.000 WX 0.000RIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.3189	.97	.2347E+04	.7662E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.3189	.97	.2347E+04	.7662E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.3189	.97	.2347E+04	.7662E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.3189	.97	.2347E+04	.7662E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.3189	.97	.2347E+04	.7662E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.3189	.97	.2347E+04	.7662E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.3189	.97	.2347E+04	.7662E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.3189	.97	.2347E+04	.7662E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.2477	.75	.1810E+04	.1496E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.2477	.75	.1810E+04	.1496E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.2477	.75	.1810E+04	.1496E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.2477	.75	.1810E+04	.1496E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.2477	.75	.1810E+04	.1496E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.2477	.75	.1810E+04	.1496E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.2477	.75	.1810E+04	.1496E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.2477	.75	.1810E+04	.1496E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.1672	.55	.1329E+04	.1551E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.1672	.55	.1329E+04	.1551E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.1672	.55	.1329E+04	.1551E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.1672	.55	.1329E+04	.1551E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.1672	.55	.1329E+04	.1551E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.1672	.55	.1329E+04	.1551E+02

23	23	0	.1167E-01	.132380	.198120	.252593	.1572	.55	.1329E+04	.1551E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.1672	.55	.1329E+04	.1551E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.0840	.39	.9403E+03	.1328E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.0840	.39	.9403E+03	.1328E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.0840	.39	.9403E+03	.1328E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.0840	.39	.9403E+03	.1328E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.0840	.39	.9403E+03	.1328E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.0840	.39	.9403E+03	.1328E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.0840	.39	.9403E+03	.1328E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.0840	.39	.9403E+03	.1328E+02
33	33	1	.7700E-02	.067597	-.339832	.425301	.0213	.19	.4659E+03	.3587E+01
34	34	1	.7700E-02	.192500	-.288096	.425301	.0213	.19	.4659E+03	.3587E+01
35	35	1	.7700E-02	.288096	-.192500	.425301	.0213	.19	.4659E+03	.3587E+01
36	36	1	.7700E-02	.339832	-.067597	.425301	.0213	.19	.4659E+03	.3587E+01
37	37	1	.7700E-02	.339832	.067597	.425301	.0213	.19	.4659E+03	.3587E+01
38	38	1	.7700E-02	.288096	.192500	.425301	.0213	.19	.4659E+03	.3587E+01
39	39	1	.7700E-02	.192500	.288096	.425301	.0213	.19	.4659E+03	.3587E+01
40	40	1	.7700E-02	.067597	.339832	.425301	.0213	.19	.4659E+03	.3587E+01

FX = 0. FD = .5331806E+03 FN = -.6872372F-07 SMX = -.6088700F-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2799583 CN = -.0000000 MX = -.0000300 MY = 0.0000000 MZ = 0.0000000

STEP 10 DEPTH = .5800010 TIME = .0083047 DIMENSIONLESS TIME .4152328 WETTING FACTORS = 1.1530000 1.1377000
AVERAGE VELOCITY 0.000 0.000 -50.060 WX 0.00ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.3622	.94	.2288E+04	.7472E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.3622	.94	.2288E+04	.7472E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.3622	.94	.2288E+04	.7472E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.3622	.94	.2288E+04	.7472E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.3622	.94	.2288E+04	.7472E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.3622	.94	.2288E+04	.7472E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.3622	.94	.2288E+04	.7472E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.3622	.94	.2288E+04	.7472E+01
9	9	0	.8265E-02	.031660	-.156150	.154806	.2911	.72	.1753E+04	.1449E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.2911	.72	.1753E+04	.1449E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.2911	.72	.1753E+04	.1449E+02
12	12	0	.8265E-02	.156150	-.031660	.154806	.2911	.72	.1753E+04	.1449E+02
13	13	0	.8265E-02	.156150	.0[illegible]	.154806	.2911	.72	.1753E+04	.1449E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.2911	.72	.1753E+04	.1449E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.2911	.72	.1753E+04	.1449E+02
16	16	0	.8265E-02	.031660	.156150	.154806	.2911	.72	.1753E+04	.1449E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.2106	.52	.1271E+04	.1484E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.2106	.52	.1271E+04	.1484E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.2106	.52	.1271E+04	.1484E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.2106	.52	.1271E+04	.1484E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.2106	.52	.1271E+04	.1484E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.2106	.52	.1271E+04	.1484E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.2106	.52	.1271E+04	.1484E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.2106	.52	.1271E+04	.1484E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.1274	.37	.8908E+03	.1258E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.1274	.37	.8908E+03	.1258E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.1274	.37	.8908E+03	.1258E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.1274	.37	.8908E+03	.1258E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.1274	.37	.8908E+03	.1258E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.1274	.37	.8908E+03	.1258E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.1274	.37	.8908E+03	.1258E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.1274	.37	.8908E+03	.1258E+02
33	33	0	.1595E-01	.070115	-.352493	.451159	.0422	.10	.2439E+03	.3891E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.0422	.10	.2439E+03	.3891E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.0422	.10	.2439E+03	.3891E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.0422	.10	.2439E+03	.3891E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.0422	.10	.2439E+03	.3891E+01
38	38	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

39	39	0	.1595E-01	.199671	.298829	.451159	.0422	.10	.2439E+03	.3891E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.0422	.10	.2439E+03	.3891E+01

FX = 0. FD = .5159396E+03 FN = -.7234581E-07 SMX = -.6561867E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2704055 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 11 DEPTH = .5500010 TIME = .0091836 DIMENSIONLESS TIME .4591811 WETTING FACTORS = 1.1377000 1.1300000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	IS	CP	P	FORCE
1	1	0	.3265E-02	.014339	-.072081	.066637	.4062	.92	.2224E+04	.7263E+01
2	2	0	.3265E-02	.040831	-.061106	.066637	.4062	.92	.2224E+04	.7263E+01
3	3	0	.3265E-02	.061106	-.040831	.066637	.4062	.92	.2224E+04	.7263E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.4062	.92	.2224E+04	.7263E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.4062	.92	.2224E+04	.7263E+01
6	6	0	.3265E-02	.061106	.040831	.066637	.4062	.92	.2224E+04	.7263E+01
7	7	0	.3265E-02	.040831	.061106	.066637	.4062	.92	.2224E+04	.7263E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.4062	.92	.2224E+04	.7263E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.3350	.69	.1685E+04	.1393E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.3350	.69	.1685E+04	.1393E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.3350	.69	.1685E+04	.1393E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.3350	.69	.1685E+04	.1393E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.3350	.69	.1685E+04	.1393E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.3350	.69	.1685E+04	.1393E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.3350	.69	.1685E+04	.1393E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.3350	.69	.1685E+04	.1393E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.2545	.49	.1188E+04	.1387E+02
18	18	0	.1167E-01	.132380	-.194120	.252593	.2545	.49	.1188E+04	.1387E+02
19	19	0	.1167E-01	.194120	-.132380	.252593	.2545	.49	.1188E+04	.1387E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.2545	.49	.1188E+04	.1387E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.2545	.49	.1188E+04	.1387E+02
22	22	0	.1167E-01	.194120	.132380	.252593	.2545	.49	.1188E+04	.1387E+02
23	23	0	.1167E-01	.132380	.194120	.252593	.2545	.49	.1188E+04	.1387E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.2545	.49	.1188E+04	.1387E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.1714	.32	.7659E+03	.1082E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.1714	.32	.7659E+03	.1082E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.1714	.32	.7659E+03	.1082E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.1714	.32	.7659E+03	.1082E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.1714	.32	.7659E+03	.1082E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.1714	.32	.7659E+03	.1082E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.1714	.32	.7659E+03	.1082E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.1714	.32	.7659E+03	.1082E+02
33	33	0	.1595E-01	.070115	-.352493	.451159	.0862	.17	.4170E+03	.6654E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.0862	.17	.4170E+03	.6654E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.0862	.17	.4170E+03	.6654E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.0862	.17	.4170E+03	.6654E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.0862	.17	.4170E+03	.6654E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.0862	.17	.4170E+03	.6654E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.0862	.17	.4170E+03	.6654E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.0862	.17	.4170E+03	.6654E+01
41	41	1	.8444E-02	.076850	-.386351	.525213	.0218	.02	.4795E+02	.4049E+00
42	42	1	.8444E-02	.218850	-.327533	.525213	.0218	.02	.4795E+02	.4049E+00
43	43	1	.8444E-02	.327533	-.218850	.525213	.0218	.02	.4795E+02	.4049E+00
44	44	1	.8444E-02	.386351	-.076850	.525213	.0218	.02	.4795E+02	.4049E+00
45	45	1	.8444E-02	.386351	.076850	.525213	.0218	.02	.4795E+02	.4049E+00
46	46	1	.8444E-02	.327533	.218850	.525213	.0218	.02	.4795E+02	.4049E+00
47	47	1	.8444E-02	.218850	.327533	.525213	.0218	.02	.4795E+02	.4049E+00
48	48	1	.8444E-02	.076850	.386351	.525213	.0218	.02	.4795E+02	.4049E+00

FX = 0. FD = .5058057E+03 FN = -.9600806E-07 SMX = -.8159410E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2655847 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 12 DEPTH = .6000010 TIME = .0100646 DIMENSIONLESS TIME .5034289 WETTING FACTORS = 1.1300000 1.1141000
AVERAGE VELOCITY 0.000 0.000 -60.000 WX 0.000RIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.4504	.90	.2174E+04	.7099E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.4504	.90	.2174E+04	.7099E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.4504	.90	.2174E+04	.7099E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.4504	.90	.2174E+04	.7099E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.4504	.90	.2174E+04	.7099E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.4504	.90	.2174E+04	.7099E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.4504	.90	.2174E+04	.7099E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.4504	.90	.2174E+04	.7099E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.3793	.67	.1636E+04	.1352E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.3793	.67	.1636E+04	.1352E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.3793	.67	.1636E+04	.1352E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.3793	.67	.1636E+04	.1352E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.3793	.67	.1636E+04	.1352E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.3793	.67	.1636E+04	.1352E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.3793	.67	.1636E+04	.1352E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.3793	.67	.1636E+04	.1352E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.2988	.47	.1138E+04	.1329E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.2988	.47	.1138E+04	.1329E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.2988	.47	.1138E+04	.1329E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.2988	.47	.1138E+04	.1329E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.2988	.47	.1138E+04	.1329E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.2988	.47	.1138E+04	.1329E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.2988	.47	.1138E+04	.1329E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.2988	.47	.1138E+04	.1329E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.2156	.30	.7170E+03	.1013E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.2156	.30	.7170E+03	.1013E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.2156	.30	.7170E+03	.1013E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.2156	.30	.7170E+03	.1013E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.2156	.30	.7170E+03	.1013E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.2156	.30	.7170E+03	.1013E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.2156	.30	.7170E+03	.1013E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.2156	.30	.7170E+03	.1013E+02
33	33	0	.1595E-01	.070115	-.352493	.451159	.1304	.16	.3908E+03	.6235E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.1304	.16	.3908E+03	.6235E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.1304	.16	.3908E+03	.6235E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.1304	.16	.3908E+03	.6235E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.1304	.16	.3908E+03	.6235E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.1304	.16	.3908E+03	.6235E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.1304	.16	.3908E+03	.6235E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.1304	.16	.3908E+03	.6235E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.0434	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.0434	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.0434	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.0434	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.0434	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.0434	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.0434	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.0434	0.00	0.	0.

FX = 0. FD = .4628733E+03 FN = -.3944123E-07 SMX = -.4272517E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2535434 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 13 DEPTH = .6500010 TIME = .0109652 DIMENSIONLESS TIME .5483082 WETTING FACTORS = 1.1141000 1.1060060
AVERAGE VELOCITY 0.000 0.000 -60.000 WX 0.000RIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.4953	.88	.2123E+04	.6931E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.4953	.88	.2123E+04	.6931E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.4953	.88	.2123E+04	.6931E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.4953	.88	.2123E+04	.6931E+01

5	5	0	.3265E-02	.072081	.014338	.066637	.4953	.88	.2123E+04	.6931E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.4953	.88	.2123E+04	.6931E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.4953	.88	.2123E+04	.6931E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.4953	.88	.2123E+04	.6931E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.4241	.65	.1584E+04	.1309E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.4241	.65	.1584E+04	.1309E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.4241	.65	.1584E+04	.1309E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.4241	.65	.1584E+04	.1309E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.4241	.65	.1584E+04	.1309E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.4241	.65	.1584E+04	.1309E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.4241	.65	.1584E+04	.1309E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.4241	.65	.1584E+04	.1309E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.3437	.45	.1080E+04	.1260E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.3437	.45	.1080E+04	.1260E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.3437	.45	.1080E+04	.1260E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.3437	.45	.1080E+04	.1260E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.3437	.45	.1080E+04	.1260E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.3437	.45	.1080E+04	.1260E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.3437	.45	.1080E+04	.1260E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.3437	.45	.1080E+04	.1260E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.2605	.27	.6477E+03	.9148E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.2605	.27	.6477E+03	.9148E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.2605	.27	.6477E+03	.9148E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.2605	.27	.6477E+03	.9148E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.2605	.27	.6477E+03	.9148E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.2605	.27	.6477E+03	.9148E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.2605	.27	.6477E+03	.9148E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.2605	.27	.6477E+03	.9148E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.1753	.12	.2931E+03	.4677E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.1753	.12	.2931E+03	.4677E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.1753	.12	.2931E+03	.4677E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.1753	.12	.2931E+03	.4677E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.1753	.12	.2931E+03	.4677E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.1753	.12	.2931E+03	.4677E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.1753	.12	.2931E+03	.4677E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.1753	.12	.2931E+03	.4677E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.0882	.00	.9997E+01	.1731E+00
42	42	0	.1732E-01	.224573	-.336097	.550830	.0882	.00	.9997E+01	.1731E+00
43	43	0	.1732E-01	.336097	-.224573	.550830	.0882	.00	.9997E+01	.1731E+00
44	44	0	.1732E-01	.396454	-.078860	.550830	.0882	.00	.9997E+01	.1731E+00
45	45	0	.1732E-01	.396454	.078860	.550830	.0882	.00	.9997E+01	.1731E+00
46	46	0	.1732E-01	.336097	.224573	.550830	.0882	.00	.9997E+01	.1731E+00
47	47	0	.1732E-01	.224573	.336097	.550830	.0882	.00	.9997E+01	.1731E+00
48	48	0	.1732E-01	.078860	.396454	.550830	.0882	.00	.9997E+01	.1731E+00
49	49	1	.9009E-02	.084267	-.423638	.625153	.0223	0.00	0.	0.
50	50	1	.9009E-02	.239971	-.359143	.625153	.0223	0.00	0.	0.
51	51	1	.9009E-02	.359143	-.239971	.625153	.0223	0.00	0.	0.
52	52	1	.9009E-02	.423638	-.084267	.625153	.0223	0.00	0.	0.
53	53	1	.9009E-02	.423638	.084267	.625153	.0223	0.00	0.	0.
54	54	1	.9009E-02	.359143	.239971	.625153	.0223	0.00	0.	0.
55	55	1	.9009E-02	.239971	.359143	.625153	.0223	0.00	0.	0.
56	56	1	.9009E-02	.084267	.423638	.625153	.0223	0.00	0.	0.

FX = 0. FD = .4515229E+03 FN = -.9426822E-07 SMX = -.7883373E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2370421 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 14 DEPTH = .7000010 TIME = .0118703 DIMENSIONLESS TIME .5935161 WETTING FACTORS = 1.1063200 1.0895000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000RIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.5405	.86	.2081E+04	.6796E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.5405	.86	.2081E+04	.6796E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.5405	.86	.2081E+04	.6796E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.5405	.86	.2081E+04	.6796E+01

5	5	0	.3265E-02	.072081	.014338	.066637	.5405	.86	.2081E+04	.6796E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.5405	.86	.2081E+04	.6796E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.5405	.86	.2081E+04	.6796E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.5405	.86	.2081E+04	.6796E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.4693	.64	.1543E+04	.1275E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.4693	.64	.1543E+04	.1275E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.4693	.64	.1543E+04	.1275E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.4693	.64	.1543E+04	.1275E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.4693	.64	.1543E+04	.1275E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.4693	.64	.1543E+04	.1275E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.4693	.64	.1543E+04	.1275E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.4693	.64	.1543E+04	.1275E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.3889	.43	.1038E+04	.1211E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.3889	.43	.1038E+04	.1211E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.3889	.43	.1038E+04	.1211E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.3889	.43	.1038E+04	.1211E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.3889	.43	.1038E+04	.1211E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.3889	.43	.1038E+04	.1211E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.3889	.43	.1038E+04	.1211E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.3889	.43	.1038E+04	.1211E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.3057	.25	.6041E+03	.8533E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.3057	.25	.6041E+03	.8533E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.3057	.25	.6041E+03	.8533E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.3057	.25	.6041E+03	.8533E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.3057	.25	.6041E+03	.8533E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.3057	.25	.6041E+03	.8533E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.3057	.25	.6041E+03	.8533E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.3057	.25	.6041E+03	.8533E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.2205	.10	.2515E+03	.4012E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.2205	.10	.2515E+03	.4012E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.2205	.10	.2515E+03	.4012E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.2205	.10	.2515E+03	.4012E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.2205	.10	.2515E+03	.4012E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.2205	.10	.2515E+03	.4012E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.2205	.10	.2515E+03	.4012E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.2205	.10	.2515E+03	.4012E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.1335	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.1335	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.1335	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.1335	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.1335	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.1335	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.1335	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.1335	0.00	0.	0.
49	49	0	.1835E-01	.085834	-.431519	.650598	.0445	0.00	0.	0.
50	50	0	.1835E-01	.244436	-.365824	.650598	.0445	0.00	0.	0.
51	51	0	.1835E-01	.365824	-.244436	.650598	.0445	0.00	0.	0.
52	52	0	.1835E-01	.431519	-.085834	.650598	.0445	0.00	0.	0.
53	53	0	.1835E-01	.431519	.085834	.650598	.0445	0.00	0.	0.
54	54	0	.1835E-01	.365824	.244436	.650598	.0445	0.00	0.	0.
55	55	0	.1835E-01	.244436	.365824	.650598	.0445	0.00	0.	0.
56	56	0	.1835E-01	.085834	.431519	.650598	.0445	0.00	0.	0.

FX = 0. FD = .4307726E+03 FN = -.4762023E-07 SMX = -.4480727E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2261867 CN = -.0000060 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 15 DEPTH = .7500010 TIME = .0127832 DIMENSIONLESS TIME .6394088 WETTING FACTORS = 1.0895000 1.0811000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000RIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.5864	.84	.2039E+04	.6656E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.5864	.84	.2039E+04	.6656E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.5864	.84	.2039E+04	.6656E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.5864	.84	.2039E+04	.6656E+01

5	5	0	.3265E-02	.072081	.014338	.066637	.5864	.84	.2039E+04	.6656E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.5864	.84	.2039E+04	.6656E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.5864	.84	.2039E+04	.6656E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.5864	.84	.2039E+04	.6656E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.5152	.62	.1500E+04	.1240E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.5152	.62	.1500E+04	.1240E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.5152	.62	.1500E+04	.1240E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.5152	.62	.1500E+04	.1240E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.5152	.62	.1500E+04	.1240E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.5152	.62	.1500E+04	.1240E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.5152	.62	.1500E+04	.1240E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.5152	.62	.1500E+04	.1240E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.4348	.41	.9924E+03	.1158E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.4348	.41	.9924E+03	.1158E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.4348	.41	.9924E+03	.1158E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.4348	.41	.9924E+03	.1158E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.4348	.41	.9924E+03	.1158E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.4348	.41	.9924E+03	.1158E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.4348	.41	.9924E+03	.1158E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.4348	.41	.9924E+03	.1158E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.3516	.23	.5538E+03	.7822E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.3516	.23	.5538E+03	.7822E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.3516	.23	.5538E+03	.7822E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.3516	.23	.5538E+03	.7822E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.3516	.23	.5538E+03	.7822E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.3516	.23	.5538E+03	.7822E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.3516	.23	.5538E+03	.7822E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.3516	.23	.5538E+03	.7822E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.2664	.08	.1922E+03	.3067E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.2664	.08	.1922E+03	.3067E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.2664	.08	.1922E+03	.3067E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.2664	.08	.1922E+03	.3067E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.2664	.08	.1922E+03	.3067E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.2664	.08	.1922E+03	.3067E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.2664	.08	.1922E+03	.3067E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.2664	.08	.1922E+03	.3067E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.1793	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.1793	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.1793	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.1793	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.1793	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.1793	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.1793	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.1793	0.00	0.	0.
49	49	0	.1835E-01	.085834	-.431519	.650598	.0904	0.00	0.	0.
50	50	0	.1835E-01	.244436	-.365824	.650598	.0904	0.00	0.	0.
51	51	0	.1835E-01	.365824	-.244436	.650598	.0904	0.00	0.	0.
52	52	0	.1835E-01	.431519	-.085834	.650598	.0904	0.00	0.	0.
53	53	0	.1835E-01	.431519	.085834	.650598	.0904	0.00	0.	0.
54	54	0	.1835E-01	.365824	.244436	.650598	.0904	0.00	0.	0.
55	55	0	.1835E-01	.244436	.365824	.650598	.0904	0.00	0.	0.
56	56	0	.1835E-01	.085834	.431519	.650598	.0904	0.00	0.	0.
57	57	1	.9430E-02	.090031	-.452617	.725187	.0228	0.00	0.	0.
58	58	1	.9430E-02	.256387	-.383710	.725187	.0228	0.00	0.	0.
59	59	1	.9430E-02	.383710	-.256387	.725187	.0228	0.00	0.	0.
60	60	1	.9430E-02	.452617	-.090031	.725187	.0228	0.00	0.	0.
61	61	1	.9430E-02	.452617	.090031	.725187	.0228	0.00	0.	0.
62	62	1	.9430E-02	.383710	.256387	.725187	.0228	0.00	0.	0.
63	63	1	.9430E-02	.256387	.383710	.725187	.0228	0.00	0.	0.
64	64	1	.9430E-02	.090031	.452617	.725187	.0228	0.00	0.	0.

FX = 0. FD = .4077368E+03 FN = -.5213650E-07 SMX = -.4620892E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2140313 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 16 DEPTH = .8800010 TIME = .0137132 DIMENSIONLESS TIME .6856579 WETTING FACTORS = 1.0811000 1.0671000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000 ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.6326	.83	.2004E+04	.6543E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.6326	.83	.2004E+04	.6543E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.6326	.83	.2004E+04	.6543E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.6326	.83	.2004E+04	.6543E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.6326	.83	.2004E+04	.6543E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.6326	.83	.2004E+04	.6543E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.6326	.83	.2004E+04	.6543E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.6326	.83	.2004E+04	.6543E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.5615	.60	.1466E+04	.1212E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.5615	.60	.1466E+04	.1212E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.5615	.60	.1466E+04	.1212E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.5615	.60	.1466E+04	.1212E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.5615	.60	.1466E+04	.1212E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.5615	.60	.1466E+04	.1212E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.5615	.60	.1466E+04	.1212E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.5615	.60	.1466E+04	.1212E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.4810	.39	.9571E+03	.1117E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.4810	.39	.9571E+03	.1117E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.4810	.39	.9571E+03	.1117E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.4810	.39	.9571E+03	.1117E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.4810	.39	.9571E+03	.1117E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.4810	.39	.9571E+03	.1117E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.4810	.39	.9571E+03	.1117E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.4810	.39	.9571E+03	.1117E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.3978	.21	.5172E+03	.7305E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.3978	.21	.5172E+03	.7305E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.3978	.21	.5172E+03	.7305E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.3978	.21	.5172E+03	.7305E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.3978	.21	.5172E+03	.7305E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.3978	.21	.5172E+03	.7305E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.3978	.21	.5172E+03	.7305E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.3978	.21	.5172E+03	.7305E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.3126	.06	.1538E+03	.2453E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.3126	.06	.1538E+03	.2453E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.3126	.06	.1538E+03	.2453E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.3126	.06	.1538E+03	.2453E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.3126	.06	.1538E+03	.2453E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.3126	.06	.1538E+03	.2453E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.3126	.06	.1538E+03	.2453E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.3126	.06	.1538E+03	.2453E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.2256	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.2256	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.2256	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.2256	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.2256	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.2256	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.2256	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.2256	0.00	0.	0.
49	49	0	.1835E-01	.085834	-.431519	.650598	.1366	0.00	0.	0.
50	50	0	.1835E-01	.244436	-.365824	.650598	.1366	0.00	0.	0.
51	51	0	.1835E-01	.365824	-.244436	.650598	.1366	0.00	0.	0.
52	52	0	.1835E-01	.431519	-.085834	.650598	.1366	0.00	0.	0.
53	53	0	.1835E-01	.431519	.085834	.650598	.1366	0.00	0.	0.
54	54	0	.1835E-01	.365824	.244436	.650598	.1366	0.00	0.	0.
55	55	0	.1835E-01	.244436	.365824	.650598	.1366	0.00	0.	0.
56	56	0	.1835E-01	.085834	.431519	.650598	.1366	0.00	0.	0.
57	57	0	.1910E-01	.091194	-.458461	.750420	.0457	0.00	0.	0.
58	58	0	.1910E-01	.259697	-.388665	.750420	.0457	0.00	0.	0.
59	59	0	.1910E-01	.388665	-.259697	.750420	.0457	0.00	0.	0.
60	60	0	.1910E-01	.458461	-.091194	.750420	.0457	0.00	0.	0.
61	61	0	.1910E-01	.458461	.091194	.750420	.0457	0.00	0.	0.
62	62	0	.1910E-01	.388665	.259697	.750420	.0457	0.00	0.	0.

63	63	0	.1910E-01	.259697	.388665	.750420	.0457	0.00	0.	0.
64	64	0	.1910E-01	.091194	.458461	.750420	.0457	0.00	0.	0.

FX = 0. FD = .3907734E+03 FN = -.5292426E-07 SMX = -.4581138E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2051874 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 17 DEPTH = .8500010 TIME = .0146503 DIMENSIONLESS TIME .7325139 WETTING FACTORS = 1.0671000 1.0615000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	#OO	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.6795	.81	.1967E+04	.6421E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.6795	.81	.1967E+04	.6421E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.6795	.81	.1967E+04	.6421E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.6795	.81	.1967E+04	.6421E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.6795	.81	.1967E+04	.6421E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.6795	.81	.1967E+04	.6421E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.6795	.81	.1967E+04	.6421E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.6795	.81	.1967E+04	.6421E+01
9	9	0	.8265E-02	.031060	-.156150	.154606	.6083	.59	.1428E+04	.1180E+02
10	10	0	.8265E-02	.088452	-.132378	.154606	.6083	.59	.1428E+04	.1180E+02
11	11	0	.8265E-02	.132378	-.088452	.154606	.6083	.59	.1428E+04	.1180E+02
12	12	0	.8265E-02	.156150	-.031060	.154606	.6083	.59	.1428E+04	.1180E+02
13	13	0	.8265E-02	.156150	.031060	.154606	.6083	.59	.1428E+04	.1180E+02
14	14	0	.8265E-02	.132378	.088452	.154606	.6083	.59	.1428E+04	.1180E+02
15	15	0	.8265E-02	.088452	.132378	.154606	.6083	.59	.1428E+04	.1180E+02
16	16	0	.8265E-02	.031060	.156150	.154606	.6083	.59	.1428E+04	.1180E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.5279	.38	.9164E+03	.1070E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.5279	.38	.9164E+03	.1070E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.5279	.38	.9164E+03	.1070E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.5279	.38	.9164E+03	.1070E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.5279	.38	.9164E+03	.1070E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.5279	.38	.9164E+03	.1070E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.5279	.38	.9164E+03	.1070E+02
24	24	0	.1167E-01	.046486	.233 95	.252593	.5279	.38	.9164E+03	.1070E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.4447	.19	.4723E+03	.6671E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.4447	.19	.4723E+03	.6671E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.4447	.19	.4723E+03	.6671E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.4447	.19	.4723E+03	.6671E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.4447	.19	.4723E+03	.6671E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.4447	.19	.4723E+03	.6671E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.4447	.19	.4723E+03	.6671E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.4447	.19	.4723E+03	.6671E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.3595	.04	.1026E+03	.1638E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.3595	.04	.1026E+03	.1638E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.3595	.04	.1026E+03	.1638E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.3595	.04	.1026E+03	.1638E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.3595	.04	.1026E+03	.1638E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.3595	.04	.1026E+03	.1638E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.3595	.04	.1026E+03	.1638E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.3595	.04	.1026E+03	.1638E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.2725	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.2725	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.2725	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.2725	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.2725	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.2725	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.2725	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.2725	0.00	0.	0.
49	49	0	.1835E-01	.085834	-.431519	.650598	.1835	0.00	0.	0.
50	50	0	.1835E-01	.244436	-.365824	.650598	.1835	0.00	0.	0.
51	51	0	.1835E-01	.365824	-.244436	.650598	.1835	0.00	0.	0.
52	52	0	.1835E-01	.431519	-.085834	.650598	.1835	0.00	0.	0.
53	53	0	.1835E-01	.431519	.085834	.650598	.1835	0.00	0.	0.
54	54	0	.1835E-01	.365824	.244436	.650598	.1835	0.00	0.	0.

55	55	0	.1835E-01	.244436	.365324	.550598	.1835	0.00	0.	0.
56	56	0	.1835E-01	.085834	.431519	.550596	.1835	0.00	0.	0.
57	57	0	.1910E-01	.091194	-.458461	.750420	.0925	0.00	0.	0.
58	58	0	.1910E-01	.259697	-.388665	.750420	.0925	0.00	0.	0.
59	59	0	.1910E-01	.388665	-.259697	.750420	.0925	0.00	0.	0.
60	60	0	.1910E-01	.458461	-.091194	.750420	.0925	0.00	0.	0.
61	61	0	.1910E-01	.458461	.091194	.750420	.0925	0.00	0.	0.
62	62	0	.1910E-01	.388665	.259697	.750420	.0925	0.00	0.	0.
63	63	0	.1910E-01	.259697	.388665	.750420	.0925	0.00	0.	0.
64	64	0	.1910E-01	.091194	.458461	.750420	.0925	0.00	0.	0.
65	65	1	.9734E-02	.094258	-.473869	.825070	.0234	0.00	0.	0.
66	66	1	.9734E-02	.268425	-.401727	.825070	.0234	0.00	0.	0.
67	67	1	.9734E-02	.401727	-.268425	.825070	.0234	0.00	0.	0.
68	68	1	.9734E-02	.473869	-.094258	.825070	.0234	0.00	0.	0.
69	69	1	.9734E-02	.473869	.094258	.825070	.0234	0.00	0.	0.
70	70	1	.9734E-02	.401727	.268425	.825070	.0234	0.00	0.	0.
71	71	1	.9734E-02	.268425	.401727	.825070	.0234	0.00	0.	0.
72	72	1	.9734E-02	.094258	.473869	.825070	.0234	0.00	0.	0.

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CX = 0.0000000 CD = .1944862 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

EXAMPLE 4

```
*******PROGRAM OPTIONS*******
CONSTANT BODY ORIENTATION
DON*T PRINT
SYMMETRIC  CONFIGURATION

*******PROBLEM PARAMETERS*******
      DIAMETER  .2500 FT
      ENTRY VELOCITY     100.000(FT/SEC)
      BODY ORIENTATION ANGLE  60.00 DEGREES
INITIAL DEPTH    .12500 FT   TERMINATION STEP  1
    INITIAL PRESSURE CORRECTION FACTOR =  1.0000
CENTROIDE COORDINATES      0.00000     0.00000      0.00000
      INCREMENT IN DEPTH    .0125000
      ANGLE OF ATTACK     0.00
         YAW ANGLE     0.00

      WETTING FACTORS
         1.45000

*******GRID OPTIONS*******
      STANDARD
      LIST
```

GRID SIZE

R	Z	NUMBER
.025000	0.000000	1
.075000	0.000000	4
.125000	0.000000	7

NODE	X	Y	Z	XP	YP	ZP
1	0.0000	-.0250	0.0000	0.0000	-.1299	-.0500
2	.0217	-.0125	0.0000	.0217	-.1191	-.0563
3	.0217	.0125	0.0000	.0217	-.0974	-.0688
4	-.0000	.0250	0.0000	-.0000	-.0866	-.0750
5	0.0000	-.0250	0.0000	0.0000	-.1299	-.0500
6	.0177	-.0177	0.0000	.0177	-.1236	-.0537
7	.0250	.0000	0.0000	.0250	-.1083	-.0625
8	.0177	.0177	0.0000	.0177	-.0929	-.0713
9	-.0000	.0250	0.0000	-.0000	-.0866	-.0750
10	0.0000	-.0750	0.0000	0.0000	-.1732	-.0250
11	.0530	-.0530	0.0000	.0530	-.1542	-.0360
12	.0750	.0000	0.0000	.0750	-.1083	-.0625
13	.0530	.0530	0.0000	.0530	-.0623	-.0890
14	-.0000	.0750	0.0000	-.0000	-.0433	-.1000
15	0.0000	-.0750	0.0000	0.0000	-.1732	-.0250
16	.0325	-.0676	0.0000	.0325	-.1668	-.0287
17	.0586	-.0468	0.0000	.0586	-.1488	-.0391
18	.0731	-.0167	0.0000	.0731	-.1227	-.0542
19	.0731	.0167	0.0000	.0731	-.0938	-.0708
20	.0586	.0468	0.0000	.0586	-.0678	-.0859
21	.0325	.0676	0.0000	.0325	-.0497	-.0963
22	-.0000	.0750	0.0000	-.0000	-.0433	-.1000
23	0.0000	-.1250	0.0000	0.0000	-.2165	-.0000
24	.0542	-.1126	0.0000	.0542	-.2058	-.0062
25	.0977	-.0779	0.0000	.0977	-.1757	-.0235
26	.1219	-.0278	0.0000	.1219	-.1323	-.0486
27	.1219	.0278	0.0000	.1219	-.0842	-.0764
28	.0977	.0779	0.0000	.0977	-.0408	-.1015
29	.0542	.1126	0.0000	.0542	-.0107	-.1188
30	-.0000	.1250	0.0000	-.0000	-.0000	-.1250
31	0.0000	-5.0000	3.2300	0.0000	-2.8234	5.2340
32	1.2200	-3.5500	3.2300	1.2200	-1.5676	4.5098

33	1.8500	-2.1000	3.2300	1.8500	-.3119	3.7848
34	1.7500	-.4100	3.2300	1.7500	1.1517	2.9398
35	.9900	.4500	3.2300	.9900	1.8965	2.5098
36	.8000	.6700	3.2300	.8000	2.0870	2.3998
37	.6400	.8000	3.2300	.6400	2.1996	2.3340
38	0.0000	.9000	3.2300	0.0000	2.2862	2.2848

ELEMENT	1	2	3	4	XC	YC	ZC	RC	TC	AREA
1	1	2	3	4	.00962	.00000	0.00000	.00962	90.000	.8119E-03
2	10	11	6	5	.01915	-.04623	0.00000	.05004	157.500	.1768E-02
3	11	12	7	6	.04623	-.01915	0.00000	.05004	112.500	.1768E-02
4	12	13	8	7	.04623	.01915	0.00000	.05004	67.500	.1768E-02
5	13	14	9	8	.01915	.04623	0.00000	.05004	22.500	.1768E-02
6	23	24	16	15	.02215	-.09703	0.00000	.09952	167.143	.2169E-02
7	24	25	17	16	.06205	-.07781	0.00000	.09952	141.429	.2169E-02
8	25	26	18	17	.08967	-.04318	0.00000	.09952	115.714	.2169E-02
9	26	27	19	18	.09952	.00000	0.00000	.09952	90.000	.2169E-02
10	27	28	20	19	.08967	.04318	0.00000	.09952	64.286	.2169E-02
11	28	29	21	20	.06205	.07781	0.00000	.09952	38.571	.2169E-02
12	29	30	22	21	.02215	.09703	0.00000	.09952	12.857	.2169E-02
		NO LOAD ELEMENTS								
13	31	32	24	23	.40999	-2.04611	2.11427	2.07549	171.003	.4405E+01
14	32	33	25	24	1.03232	-1.88321	2.11091	2.14760	151.270	.3318E+01
15	33	34	26	25	1.22898	-.84199	2.11494	1.48315	124.598	.3165E+01
16	34	35	27	26	.93961	.01471	2.09996	.93972	89.103	.2029E+01
17	35	36	28	27	.59281	.36481	1.97982	.69607	58.392	.5818E+00
18	36	37	29	28	.45967	.47640	1.92457	.66201	43.976	.4390E+00
19	37	38	30	29	.21477	.58753	2.06799	.62555	20.079	.1168E+01

STEP 1 COMPLETE.CP TIME FOR STEP IS 4.13100

STEP 2 COMPLETE.CP TIME FOR STEP IS 4.14700

STEP 3 COMPLETE.CP TIME FOR STEP IS 4.02600

STEP 2 DEPTH = .1500000 TIME = .0011945 DIMENSIONLESS TIME .4778071 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.2787	1.72	.1670E+05	.1356E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.2051	1.83	.1776E+05	.3139E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.2482	1.73	.1680E+05	.2970E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.3092	1.63	.1582E+05	.2796E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.3524	1.58	.1531E+05	.2706E+02
6	6	0	.2169E-02	.022146	-.097029	-.000000	.1242	2.06	.2002E+05	.4342E+02
7	7	0	.2169E-02	.062052	-.077811	-.000000	.1548	1.89	.1834E+05	.3979E+02
8	8	0	.2169E-02	.089669	-.043182	-.000000	.2099	1.70	.1651E+05	.3583E+02
9	9	0	.2169E-02	.099524	.000000	.000000	.2787	1.53	.1483E+05	.3217E+02
10	10	0	.2169E-02	.089668	.043182	.000000	.3475	1.43	.1387E+05	.3008E+02
11	11	0	.2169E-02	.062052	.077811	.000000	.4026	1.37	.1330E+05	.2886E+02
12	12	0	.2169E-02	.022146	.097029	.000000	.4333	1.35	.1309E+05	.2839E+02
			NO LOAD ELEMENTS							
13	13	1	.1817E-02	.030120	-.130831	.609455	.0443	.01	0.	0.
14	14	1	.2642E-02	.085860	-.107017	.016468	.0628	.01	0.	0.
15	15	1	.4774E-02	.128177	-.060338	.032246	.0937	.05	0.	0.
16	16	1	.7606E-02	.142082	.003814	.054979	.1331	-.01	0.	0.
17	17	1	.9146E-02	.127434	.065998	.074771	.1776	-.02	0.	0.
18	18	1	.1093E-01	.093331	.113687	.090321	.2106	.01	0.	0.
19	19	1	.1475E-01	.036173	.142951	.105474	.2154	.02	0.	0.

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