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THREE-DIMENSIONAL FLOW FIELD
FROM A RADIAL VORTEX FILAMENT
IN A CYLINDRICAL ANNULUS

By

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1.0 INTRODUCTION

Simplification of the problem of finding the three-dimensional potential flow field for a finite number of blades of constant circulation in an axial flow turbomachine to the determination of the three-dimensional field due to a single radial vortex filament of uniform strength in a cylindrical annulus has been made by Tyson (1). For more than one blade, the solution may be found by superposition of the single filament fields.

The Laplace equation in cylindrical coordinates

$$\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial \phi}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 \phi}{\partial \theta^2} + \frac{\partial^2 \phi}{\partial x^2} = 0 \quad [1]$$

governs the behavior of the velocity potential ϕ in the annular region with

- r = radial coordinate from the centerline,
- θ = angular position from a reference line,
- x = axial position along the annulus from a reference plane normal to the centerline,
- a = hub radius, and
- b = casing radius.

The boundary conditions state that the inner and outer cylindrical boundaries of the annulus, $r = a$ and b , are stream surfaces, and that the only singularity in the field is a single radial vortex filament located at $\theta = 0$, $x = 0$. The total circulation of the filament, Γ , is assumed to be evenly divided upstream and downstream of the filament.

Employing separation of variables and a periodic series representation, the solution for the required velocity potential may be written:

$$\Phi = \pm \frac{1}{4\pi} \left(\theta + 4 \sum_{m=1}^{\infty} \frac{\sin m\theta}{m} \sum_{n=1}^{\infty} \frac{\beta_{nm}}{\gamma_{nm}} Z_m \left(\frac{\mu_{nm} \eta}{\eta_H} \right) e^{\mp \frac{\mu_{nm} \xi}{\eta_H}} \right) \quad [2]$$

where the sign difference refers to the regions upstream and downstream of the filament location, and

Φ = dimensionless velocity potential ϕ/Γ ,

β_{nm} = constant,

γ_{nm} = constant,

J_m = Bessel function of the first kind,

Y_m = Bessel function of the second kind,

B_{nm} = constant,

$Z_m = J_m + B_{nm} Y_m$,

μ_{nm} = dimensionless Eigenvalue $\lambda_{nm} a$,

η_H = hub ratio, a/b ,

η = dimensionless radial coordinate, r/b , and

ξ = dimensionless axial coordinate, x/b .

To superpose the velocity fields due to a number of filaments (see Reference 1)

$$V = v\left(\theta + \frac{2\pi}{N}\right) + v\left(\theta + 2\frac{2\pi}{N}\right) + \dots + v\left(\theta + N\frac{2\pi}{N}\right) \quad [3]$$

where

- N = the number of filaments,
- V = the resultant tangential, radial, or axial velocity, and
- v = the tangential, radial, or axial velocity component due to a single filament.

2.0 NUMERICAL CALCULATIONS

The solution presented in Equation [2] has been programmed by HYDRONAUTICS, Incorporated using FORTRAN IV on an IBM 1130 Computer. There are two distinct calculations, required and separate programs were written for each of these. The first calculates the Eigenvalues μ_{nm} , the coefficient ratio β_{nm}/γ_{nm} , and the coefficient B_{nm} . The second uses these values to compute Φ and ultimately the dimensionless axial, tangential and radial velocity components:

$$C_{\xi} = \frac{\partial \Phi}{\partial \xi} \quad [4a]$$

$$C_{\eta} = \frac{\partial \Phi}{\partial \eta} \quad , \text{ and} \quad [4b]$$

$$C_{\theta} = \frac{\partial \Phi}{\partial \theta} \quad [4c]$$

The computer calculation time required to determine each Eigenvalue, μ_{nm} , with coefficients β_{nm}/γ_{nm} and B_{nm} , is approximately four minutes. The time required to compute each set of three velocities is dependent on the maximum values of n and m selected. If $n_{\max} = 6$ and $m_{\max} = 40$ approximately six minutes is required per set.

3.0 EIGENVALUE CALCULATIONS

The dimensionless Eigenvalues, μ_{nm} required for the evaluation of Equation [2] were calculated numerically and compared to the values given for a single hub ratio η_H of 0.60 in Reference 1, which cover the range of $n = 1, 2$ and $m = 1$ through 10, 15 and 20. The values between $m = 10, 15$ and $m = 15, 20$ were found in (1) by interpolation, and values from $m = 20$ to $m = 26$ were found by extrapolation. The present calculations, based on a trial and error solution of the eigenvalue equation, show agreement with these eigenvalues to the limit of the four significant digits presented. Figures 1, 2, and 3 present the eigenvalues calculated for $n = 1$ to 6, $m = 1$ to 40 and η_H of .70 and .80 as well as .60.

Reference 1 states that an approximate series representation (Reference 2) for μ_{nm} is available, but is not accurate for small values of n and m . This series representation was programmed and compared to the present numerical solution. Figure 4 shows that the series representation for $n = 3$ agrees to within 5 percent of the numerical values up to $m = 21$. Beyond this the

agreement becomes progressively worse until at $m = 40$, the discrepancy is more than 200 percent. Other values of n were also chosen and the eigenvalues calculated by the series approximation were compared to the exact values. The conclusion drawn was that the series is a more suitable representation of μ_{nm} when n, m are small, the reverse of the conclusion stated in Reference 1.

4.0 CONVERGENCE OF THE THREE-DIMENSIONAL SOLUTION

In order to check the influence of the number of terms (n, m) on the convergence of the solutions for velocity components at various locations with respect to the vortex filament, calculations were made with varying series lengths. It was known from (1) that convergence becomes more difficult as the filament is approached. In Reference 1 values of $n = 2, m = 26$ were used and the closest calculations to the filament were made at $\xi = 0.2, \theta = 15^\circ$. Values at $\theta = 0^\circ$ were also calculated but were zero except for C_θ .

Figure 5 shows that the number of terms used by in Reference 1 was sufficient to insure the convergence of all three velocity components at $\eta = 0.80$ for $\xi = 0.20, \theta = 15^\circ, \eta_H = 0.6$. Similar results were obtained for $n = 0.60$ and $\eta = 1.00$. In attempting to make calculations nearer to the vortex filament the limits of $n = 2, m = 26$ are no longer sufficient. Figure 6 indicates that in the region $\theta = 5^\circ, \xi = 0.05$ a series of $n = 6, m = 40$ is required with convergence for all three velocity components sensitive to both limits.

It is thus apparent that the series length required for convergence and, therefore, the time required for each calculation is strongly dependent on proximity to the filament. For a hub ratio of 0.60, a series length of $n = 6$, $m = 40$ is apparently adequate to as close as $\theta = 5^\circ$, $\alpha = 0.05$.

5.0 COMPARISON TO PREVIOUS RESULTS

The calculations of Reference 1 were repeated for the hub ratio of 0.6. Figure 7a for $\xi = 0.20$ and $\theta = 0^\circ$ to 180° , shows good agreement for the dimensionless tangential velocity component, C_θ at the mid radius, $\eta = 0.80$; but substantial deviation for the hub and tip radii. Figure 7b shows a similar result for $\xi = 0.80$, although the magnitude of the deviations between the values calculated is considerably reduced over those at $\xi = 0.20$. In general, at all but mid radius, the present calculations indicate a higher value of C_θ near the filament and lower value of C_θ far away from the filament than the results of (1).

In the case of the dimensionless axial velocity component, C_ξ , the present results again agree with Reference 1 at the mid radius, but not at the hub or tip as shown in Figures 8a and 8b. The present calculations indicate the axial velocity to be greater than reported in (1) for all values of θ .

It is difficult to explain the discrepancies between the present calculations and the previous results (1), especially since the eigenvalues have been shown to agree and the dimensionless velocities agree at the mid radius. One might only conclude

that the calculations of (1) done in 1952 and probably by desk calculator may have contained certain systematic computational errors not found in the present calculations by high speed computer.

6.0 THE TWO-DIMENSIONAL APPROXIMATION OF THE PROBLEM

The complex velocity potential, ω at position z due to a single rectilinear (two-dimensional) vortex filament with circulation, Γ , at position z_1 is given by

$$\omega = \frac{\Gamma}{2\pi} i \ln (z - z_1)$$

For a series of $2n + 1$ vortices of equal strength spaced along the x axis at intervals, a , with the center filament at the origin, the potential is

$$\omega = \frac{i\Gamma}{2\pi} \ln z (z-a)(z+a)(z-2a)(z+2a)\dots(z-na)(z+na)$$

This may be rewritten

$$\omega = \frac{i\Gamma}{2\pi} \ln \left[\frac{\pi z}{a} \left(1 - \frac{z^2}{a^2} \right) \left(1 - \frac{z^2}{4a^2} \right) \dots \left(1 - \frac{z^2}{n^2 a^2} \right) \right] + \text{constant}$$

Neglecting the constant term which has no influence on the velocity and allowing $n \rightarrow \infty$

$$\omega = \frac{i\Gamma}{2\pi} \ln \sin \left(\frac{\pi z}{a} \right)$$

The resulting complex velocity is

$$-\frac{d\omega}{dz} = u - iv = -\frac{i\Gamma}{4\pi a} \cot \frac{\pi z}{a}$$

where

u = the complex velocity component in the
x direction, and

v = the complex velocity component in the y direction.

Separating real and imaginary parts,

$$u = -\frac{\Gamma}{2a} \frac{\sinh \frac{2\pi y}{a}}{\cosh \frac{2\pi y}{a} - \cos \frac{2\pi x}{a}}$$

$$v = \frac{\Gamma}{2a} \frac{\sin \frac{2\pi x}{a}}{\cosh \frac{2\pi y}{a} - \cos \frac{2\pi x}{a}}$$

If the spacing, a , is taken to be $2\pi\eta$ and the following substitutions are made

$$y = \xi$$

$$x = \theta\eta$$

$$C_\theta = u/\Gamma$$

$$C_\xi = v/\Gamma$$

we obtain

$$C_{\theta} = - \frac{1}{4\pi\eta} \frac{\sinh(\xi/\eta)}{\cosh \xi/\eta - \cos \theta}$$

$$C_{\xi} = \frac{1}{4\pi\eta} \frac{\sin \theta}{\cosh \xi/\eta - \cos \theta}$$

These are the two-dimensional approximations to the non-dimensional axial and tangential velocities for a vortex filament in an annulus. The radial velocity of course is assumed zero at all points. The hub/diameter ratio does not appear since in two dimensions it has no significance.

These equations are of the same form used in Reference 1 to calculate limited two-dimensional results for comparison to the three-dimensional case. HYDRONAUTICS has programmed the solution to these equations and calculated C_{ξ} and C_{θ} for values of $\eta = 0.5$, to 1.0, $\theta = 5^{\circ} - 90^{\circ}$ and $\xi = 0.01$ to .80. Typical results as presented in Figures 9 and 10.

7.0 COMPARISON TO TWO-DIMENSIONAL RESULTS

In section 6.0, a two-dimensional approximation to the three-dimensional problem was presented. Typical three-dimensional results from the present calculations are now presented as the ratio of the 3-D result to the much simpler 2-D case. This method of presentation cannot be used, of course, for the radial velocity which is zero in two dimensions.

7.1 The 0.60 Hub Ratio Case

Figures 11a and 11b show the variation of the ratio of 3-D tangential velocities to 2-D values for $\xi = 0.20$ and 0.80 . From these figures it can be seen that the mid-radius velocities are equal to the two-dimensional values while the hub and tip values deviate by as much as 20 percent. The hub and tip curves are nearly mirror images of each other about the 1.0 line. The "cross-over" point where hub, tip and mid-values are all near the 2-D values moves closer to the filament in a tangential direction as the plane under consideration moves closer to the filament in an axial direction. The dip in the tip radius curve is typical.

Figures 12a and 12b present similar results for the axial velocity components and the comments regarding tangential velocities apply in general to this case as well. The percentage of deviation between 2-D and 3-D results is, however, slightly larger in the axial case.

Figure 13 shows the influence of axial location on the tangential velocity component at the hub.

7.2 The 0.70 and 0.80 Hub Ratio Cases

Similar results were obtained when calculations were made for η_H of 0.70 and 0.80. Again, the mid radius values were in agreement with the 2-D results while the hub and tip values showed the typical systematic mirror-image deviation from the

2-D values. Figures 14 and 15 show that the 3-D results more closely approach the 2-D values when the hub ratio is increased, an intuitively correct relationship.

8.0 SAMPLE STREAMLINE INTERFERENCE CALCULATIONS

Appendix A presents a tabulation of the eigenvalues, μ_{nm} , and coefficients B_{nm} and β_{nm}/γ_{nm} required for the evaluation of Equation [2] for hub/diameter ratios of 0.60, 0.70 and 0.80. Appendix B presents a tabulation of the three-dimensional non-dimensional velocities calculated for the case of $\eta_H = 0.70$ and $\eta = 0.70, .775, .850, .925, 1.00$. The calculations of Appendix B were made with limits of $n = 2, 4, \text{ or } 6$ and $m = 26$ or 40 depending on proximity to the filament and convergence of the three-dimensional solution as discussed in section 4.0.

Bowerman (3) has presented a technique for pump impeller design which utilizes the results of the three dimensional velocity field calculation previously presented. The technique allows the design of an impeller without the use of experimental or theoretical cascade data. This is especially helpful in the case of inducers where high solidity and high stagger angles are required, since cascade performance in this range is not known. The lack of knowledge of cascade performance in this range is a major factor in the adoption of a simple, helical blade to inducer applications.

In Reference 4, the second stage of a tandem-row inducer was designed using the Bowerman design technique. Tests of this stage indicated the need for empirical modifications to improve performance. The results given by Tyson (1), however, were used in this design and as shown in Section 5.0 the present calculations disagree substantially with the results of (1) at all but the mid radius.

Using the present three-dimensional results, a sample interference streamline calculation was conducted using the following conditions:

Impeller diameter = 7.0"

Diameter under consideration, $\eta = 1.00$

Hub/diameter ratio, $\eta_H = 0.70$

Lift parameter, $C_L(C/D) = 0.493$

Solidity, $C_D = 1.795$

Chord, $c = 9.87"$

Axial extent ratio, $\xi_t = 0.641$

Diffusion factor = 0.275

Number of blades = 4

Vortex filaments/blade = 6

Design flow coefficient = 0.10

2nd stage design head coefficient = .2125

rpm of impeller = 4000

1st stage design head coefficient = .0375

Figure 16 indicates the variation of $C_{\theta \text{ total}}$ with axial location, ξ , as obtained using the three-dimensional and two-dimensional results. While there are discernable differences, the calculation indicates that, at least for hub/diameter ratios of 0.70 or greater, there is not enough difference between the results to justify the calculation of the more complicated three-dimensional values.

9.0 SUMMARY AND CONCLUSIONS

In summary:

(a) A computer program to solve the three-dimensional flow field from a radial vortex filament in a cylindrical annulus has been written.

(b) The convergence of the solutions depends on proximity to the vortex filament, with more and more terms required in the summation as the filament is approached in either the axial or tangential direction.

(c) The eigenvalues used in Reference 1 agree with the present values. The series representation of the eigenvalues (2) is valid for small values of m and n only.

(d) Considerable disagreement was found between the present three-dimensional results and the results reported in Reference 1 except at the mid-radius.

(e) A systematic deviation was found between the present three-dimensional calculations and the two-dimensional approximation with maximum differences on the order of 25 percent. The larger the hub/diameter ratio, the closer the three-dimensional results are to the two-dimensional.

(f) Eigenvalues and coefficients required for the three-dimensional calculations at hub/diameter ratios, η_H , of 0.60, 0.70 and 0.80 are tabulated in Appendix A. Actual velocities for $\eta_H = 0.70$ are tabulated in Appendix B.

(g) A sample interference streamline calculation showed little difference between $C_{\theta_{total}}$ using three-dimensional results or two-dimensional results in the summation in the case of $\eta_H = 0.70$. For this case, therefore, the more complicated three dimensional calculations are unjustified.

REFERENCES

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APPENDIX A

Eigenvalues and Coefficients
For $\eta_H = 0.60, 0.70, 0.80$

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|-------------|
| 1 | 1 | 0.60 | 0.75719 | -0.32283E 00 | 0.72145E 00 |
| 1 | 2 | 0.60 | 1.50949 | -0.30368E 00 | 0.92120E 00 |
| 1 | 3 | 0.60 | 2.25229 | -0.24767E 00 | 0.11189E 01 |
| 1 | 4 | 0.60 | 2.98179 | -0.18817E 00 | 0.13174E 01 |
| 1 | 5 | 0.60 | 3.69519 | -0.13555E 00 | 0.15115E 01 |
| 1 | 6 | 0.60 | 4.39188 | -0.93412E-01 | 0.16932E 01 |
| 1 | 7 | 0.60 | 5.07268 | -0.62017E-01 | 0.18565E 01 |
| 1 | 8 | 0.60 | 5.73958 | -0.39944E-01 | 0.19987E 01 |
| 1 | 9 | 0.60 | 6.39542 | -0.25137E-01 | 0.21206E 01 |
| 1 | 10 | 0.60 | 7.04257 | -0.15540E-01 | 0.22257E 01 |
| 1 | 11 | 0.60 | 7.68344 | -0.94859E-02 | 0.23172E 01 |
| 1 | 12 | 0.60 | 8.31962 | -0.57348E-02 | 0.23988E 01 |
| 1 | 13 | 0.60 | 8.95231 | -0.34418E-02 | 0.24728E 01 |
| 1 | 14 | 0.60 | 9.58238 | -0.20540E-02 | 0.25413E 01 |
| 1 | 15 | 0.60 | 10.21040 | -0.12202E-02 | 0.26055E 01 |
| 1 | 16 | 0.60 | 10.83686 | -0.72227E-03 | 0.26661E 01 |
| 1 | 17 | 0.60 | 11.46203 | -0.42619E-03 | 0.27240E 01 |
| 1 | 18 | 0.60 | 12.08605 | -0.25076E-03 | 0.27796E 01 |
| 1 | 19 | 0.60 | 12.70909 | -0.14717E-03 | 0.28329E 01 |
| 1 | 20 | 0.60 | 13.33134 | -0.86193E-04 | 0.28845E 01 |
| 1 | 21 | 0.60 | 13.95272 | -0.50364E-04 | 0.29344E 01 |
| 1 | 22 | 0.60 | 14.57357 | -0.29384E-04 | 0.29826E 01 |
| 1 | 23 | 0.60 | 15.19372 | -0.17111E-04 | 0.30295E 01 |
| 1 | 24 | 0.60 | 15.81326 | -0.99475E-05 | 0.30751E 01 |
| 1 | 25 | 0.60 | 16.43230 | -0.57746E-05 | 0.31193E 01 |
| 1 | 26 | 0.60 | 17.05083 | -0.33474E-05 | 0.31625E 01 |
| 1 | 27 | 0.60 | 17.66887 | -0.19378E-05 | 0.32045E 01 |
| 1 | 28 | 0.60 | 18.28651 | -0.11204E-05 | 0.32455E 01 |
| 1 | 29 | 0.60 | 18.90369 | -0.64704E-06 | 0.32856E 01 |
| 1 | 30 | 0.60 | 19.52052 | -0.37326E-06 | 0.33247E 01 |
| 1 | 31 | 0.60 | 20.13697 | -0.21509E-06 | 0.33630E 01 |
| 1 | 32 | 0.60 | 20.75306 | -0.12382E-06 | 0.34005E 01 |
| 1 | 33 | 0.60 | 21.36883 | -0.71219E-07 | 0.34371E 01 |
| 1 | 34 | 0.60 | 21.98428 | -0.40923E-07 | 0.34730E 01 |
| 1 | 35 | 0.60 | 22.59946 | -0.23496E-07 | 0.35083E 01 |
| 1 | 36 | 0.60 | 23.21432 | -0.13478E-07 | 0.35428E 01 |
| 1 | 37 | 0.60 | 23.82893 | -0.77265E-08 | 0.35767E 01 |
| 1 | 38 | 0.60 | 24.44327 | -0.44256E-08 | 0.36100E 01 |
| 1 | 39 | 0.60 | 25.05735 | -0.25330E-08 | 0.36427E 01 |
| 1 | 40 | 0.60 | 25.67120 | -0.14489E-08 | 0.36748E 01 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 2 | 1 | 0.60 | 4.82458 | -0.53194E 00 | -0.14584E-01 |
| 2 | 2 | 0.60 | 5.02018 | -0.63626E 02 | -0.10221E-02 |
| 2 | 3 | 0.60 | 5.33357 | 0.10500E 01 | 0.98395E-01 |
| 2 | 4 | 0.60 | 5.74937 | 0.27589E 00 | 0.23496E 00 |
| 2 | 5 | 0.60 | 6.25117 | -0.88307E-01 | 0.35805E 00 |
| 2 | 6 | 0.60 | 6.82291 | -0.31779E 00 | 0.45726E 00 |
| 2 | 7 | 0.60 | 7.44934 | -0.45483E 00 | 0.54332E 00 |
| 2 | 8 | 0.60 | 8.11681 | -0.51393E 00 | 0.62843E 00 |
| 2 | 9 | 0.60 | 8.81327 | -0.51287E 00 | 0.71968E 00 |
| 2 | 10 | 0.60 | 9.52841 | -0.47275E 00 | 0.81927E 00 |
| 2 | 11 | 0.60 | 10.25412 | -0.41229E 00 | 0.92551E 00 |
| 2 | 12 | 0.60 | 10.98338 | -0.34478E 00 | 0.10355E 01 |
| 2 | 13 | 0.60 | 11.71115 | -0.27860E 00 | 0.11455E 01 |
| 2 | 14 | 0.60 | 12.43377 | -0.21852E 00 | 0.12513E 01 |
| 2 | 15 | 0.60 | 13.14880 | -0.16688E 00 | 0.13495E 01 |
| 2 | 16 | 0.60 | 13.85512 | -0.12439E 00 | 0.14379E 01 |
| 2 | 17 | 0.60 | 14.55260 | -0.90757E-01 | 0.15154E 01 |
| 2 | 18 | 0.60 | 15.24180 | -0.64981E-01 | 0.15826E 01 |
| 2 | 19 | 0.60 | 15.92373 | -0.45786E-01 | 0.16404E 01 |
| 2 | 20 | 0.60 | 16.59946 | -0.31823E-01 | 0.16906E 01 |
| 2 | 21 | 0.60 | 17.27005 | -0.21862E-01 | 0.17349E 01 |
| 2 | 22 | 0.60 | 17.93642 | -0.14871E-01 | 0.17746E 01 |
| 2 | 23 | 0.60 | 18.59936 | -0.10030E-01 | 0.18109E 01 |
| 2 | 24 | 0.60 | 19.25946 | -0.67156E-02 | 0.18447E 01 |
| 2 | 25 | 0.60 | 19.91725 | -0.44671E-02 | 0.18767E 01 |
| 2 | 26 | 0.60 | 20.57305 | -0.29535E-02 | 0.19071E 01 |
| 2 | 27 | 0.60 | 21.22714 | -0.19424E-02 | 0.19365E 01 |
| 2 | 28 | 0.60 | 21.87977 | -0.12712E-02 | 0.19649E 01 |
| 2 | 29 | 0.60 | 22.53105 | -0.82814E-03 | 0.19925E 01 |
| 2 | 30 | 0.60 | 23.18112 | -0.53718E-03 | 0.20195E 01 |
| 2 | 31 | 0.60 | 23.83011 | -0.34706E-03 | 0.20459E 01 |
| 2 | 32 | 0.60 | 24.47808 | -0.22338E-03 | 0.20717E 01 |
| 2 | 33 | 0.60 | 25.12509 | -0.14327E-03 | 0.20969E 01 |
| 2 | 34 | 0.60 | 25.77121 | -0.91580E-04 | 0.21217E 01 |
| 2 | 35 | 0.60 | 26.41647 | -0.58348E-04 | 0.21460E 01 |
| 2 | 36 | 0.60 | 27.06095 | -0.37064E-04 | 0.21698E 01 |
| 2 | 37 | 0.60 | 27.70464 | -0.23475E-04 | 0.21932E 01 |
| 2 | 38 | 0.60 | 28.34763 | -0.14827E-04 | 0.22162E 01 |
| 2 | 39 | 0.60 | 28.98989 | -0.93406E-05 | 0.22388E 01 |
| 2 | 40 | 0.60 | 29.63150 | -0.58694E-05 | 0.22609E 01 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 3 | 1 | 0.60 | 9.48061 | 0.13519E 01 | 0.55457E-03 |
| 3 | 2 | 0.60 | 9.57685 | -0.40235E 00 | 0.36439E-02 |
| 3 | 3 | 0.60 | 9.73549 | -0.28802E 02 | 0.32711E-03 |
| 3 | 4 | 0.60 | 9.95395 | 0.69228E 00 | -0.14771E-01 |
| 3 | 5 | 0.60 | 10.22920 | -0.25776E 00 | -0.29617E-01 |
| 3 | 6 | 0.60 | 10.55762 | -0.14934E 01 | -0.26868E-01 |
| 3 | 7 | 0.60 | 10.93553 | 0.44780E 02 | 0.16171E-02 |
| 3 | 8 | 0.60 | 11.35935 | 0.17020E 01 | 0.52828E-01 |
| 3 | 9 | 0.60 | 11.82569 | 0.71756E 00 | 0.11785E 00 |
| 3 | 10 | 0.60 | 12.33144 | 0.29440E 00 | 0.18770E 00 |
| 3 | 11 | 0.60 | 12.87389 | 0.21986E-01 | 0.25631E 00 |
| 3 | 12 | 0.60 | 13.45034 | -0.18086E 00 | 0.32131E 00 |
| 3 | 13 | 0.60 | 14.05821 | -0.33574E 00 | 0.38343E 00 |
| 3 | 14 | 0.60 | 14.69460 | -0.44672E 00 | 0.44520E 00 |
| 3 | 15 | 0.60 | 15.35634 | -0.51365E 00 | 0.50979E 00 |
| 3 | 16 | 0.60 | 16.03958 | -0.53878E 00 | 0.57968E 00 |
| 3 | 17 | 0.60 | 16.74019 | -0.52858E 00 | 0.65597E 00 |
| 3 | 18 | 0.60 | 17.45367 | -0.49255E 00 | 0.73828E 00 |
| 3 | 19 | 0.60 | 18.17570 | -0.44061E 00 | 0.82497E 00 |
| 3 | 20 | 0.60 | 18.90204 | -0.38118E 00 | 0.91351E 00 |
| 3 | 21 | 0.60 | 19.62916 | -0.32059E 00 | 0.10010E 01 |
| 3 | 22 | 0.60 | 20.35397 | -0.26298E 00 | 0.10845E 01 |
| 3 | 23 | 0.60 | 21.07429 | -0.21094E 00 | 0.11618E 01 |
| 3 | 24 | 0.60 | 21.78870 | -0.16577E 00 | 0.12311E 01 |
| 3 | 25 | 0.60 | 22.49647 | -0.12787E 00 | 0.12918E 01 |
| 3 | 26 | 0.60 | 23.19757 | -0.96997E-01 | 0.13439E 01 |
| 3 | 27 | 0.60 | 23.89229 | -0.72484E-01 | 0.13882E 01 |
| 3 | 28 | 0.60 | 24.58130 | -0.53459E-01 | 0.14260E 01 |
| 3 | 29 | 0.60 | 25.26526 | -0.38971E-01 | 0.14585E 01 |
| 3 | 30 | 0.60 | 25.94495 | -0.28125E-01 | 0.14869E 01 |
| 3 | 31 | 0.60 | 26.62101 | -0.20116E-01 | 0.15122E 01 |
| 3 | 32 | 0.60 | 27.29403 | -0.14274E-01 | 0.15353E 01 |
| 3 | 33 | 0.60 | 27.96448 | -0.10057E-01 | 0.15567E 01 |
| 3 | 34 | 0.60 | 28.63277 | -0.70401E-02 | 0.15770E 01 |
| 3 | 35 | 0.60 | 29.29922 | -0.48991E-02 | 0.15963E 01 |
| 3 | 36 | 0.60 | 29.96405 | -0.33906E-02 | 0.16151E 01 |
| 3 | 37 | 0.60 | 30.62747 | -0.23346E-02 | 0.16333E 01 |
| 3 | 38 | 0.60 | 31.28961 | -0.15997E-02 | 0.16512E 01 |
| 3 | 39 | 0.60 | 31.95060 | -0.10912E-02 | 0.16687E 01 |
| 3 | 40 | 0.60 | 32.61054 | -0.74119E-03 | 0.16860E 01 |

HYDRONAUTICS, Incorporated

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| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 4 | 1 | 0.60 | 14.17426 | -0.81938E 00 | 0.41560E-03 |
| 4 | 2 | 0.60 | 14.23825 | 0.17601E 01 | -0.89979E-03 |
| 4 | 3 | 0.60 | 14.34416 | -0.24039E 00 | -0.39521E-02 |
| 4 | 4 | 0.60 | 14.49134 | -0.64866E 01 | -0.11088E-02 |
| 4 | 5 | 0.60 | 14.67865 | 0.75393E 00 | 0.92421E-02 |
| 4 | 6 | 0.60 | 14.90481 | -0.34510E 00 | 0.16146E-01 |
| 4 | 7 | 0.60 | 15.16837 | -0.27029E 01 | 0.83198E-02 |
| 4 | 8 | 0.60 | 15.46769 | 0.21167E 01 | -0.13870E-01 |
| 4 | 9 | 0.60 | 15.80113 | 0.44220E 00 | -0.39170E-01 |
| 4 | 10 | 0.60 | 16.16693 | -0.22373E 00 | -0.54143E-01 |
| 4 | 11 | 0.60 | 16.56359 | -0.10002E 01 | -0.50021E-01 |
| 4 | 12 | 0.60 | 16.98950 | -0.34077E 01 | -0.25113E-01 |
| 4 | 13 | 0.60 | 17.44308 | 0.64396E 01 | 0.17101E-01 |
| 4 | 14 | 0.60 | 17.92314 | 0.16766E 01 | 0.70726E-01 |
| 4 | 15 | 0.60 | 18.42836 | 0.84347E 00 | 0.12979E 00 |
| 4 | 16 | 0.60 | 18.95778 | 0.44184E 00 | 0.18962E 00 |
| 4 | 17 | 0.60 | 19.51049 | 0.17752E 00 | 0.24724E 00 |
| 4 | 18 | 0.60 | 20.08567 | -0.23390E-01 | 0.30147E 00 |
| 4 | 19 | 0.60 | 20.68264 | -0.18598E 00 | 0.35257E 00 |
| 4 | 20 | 0.60 | 21.30068 | -0.31849E 00 | 0.40183E 00 |
| 4 | 21 | 0.60 | 21.93886 | -0.42200E 00 | 0.45136E 00 |
| 4 | 22 | 0.60 | 22.59600 | -0.49500E 00 | 0.50339E 00 |
| 4 | 23 | 0.60 | 23.27053 | -0.53643E 00 | 0.55992E 00 |
| 4 | 24 | 0.60 | 23.96049 | -0.54768E 00 | 0.62221E 00 |
| 4 | 25 | 0.60 | 24.66331 | -0.53300E 00 | 0.69059E 00 |
| 4 | 26 | 0.60 | 25.37630 | -0.49858E 00 | 0.76431E 00 |
| 4 | 27 | 0.60 | 26.09637 | -0.45122E 00 | 0.84178E 00 |
| 4 | 28 | 0.60 | 26.82055 | -0.39704E 00 | 0.92079E 00 |
| 4 | 29 | 0.60 | 27.54608 | -0.34095E 00 | 0.99884E 00 |
| 4 | 30 | 0.60 | 28.27056 | -0.28651E 00 | 0.10735E 01 |
| 4 | 31 | 0.60 | 28.99204 | -0.23608E 00 | 0.11427E 01 |
| 4 | 32 | 0.60 | 29.70912 | -0.19106E 00 | 0.12051E 01 |
| 4 | 33 | 0.60 | 30.42100 | -0.15209E 00 | 0.12600E 01 |
| 4 | 34 | 0.60 | 31.12734 | -0.11926E 00 | 0.13072E 01 |
| 4 | 35 | 0.60 | 31.82819 | -0.92258E-01 | 0.13474E 01 |
| 4 | 36 | 0.60 | 32.52391 | -0.70496E-01 | 0.13815E 01 |
| 4 | 37 | 0.60 | 33.21495 | -0.53281E-01 | 0.14104E 01 |
| 4 | 38 | 0.60 | 33.90187 | -0.39878E-01 | 0.14353E 01 |
| 4 | 39 | 0.60 | 34.58523 | -0.29587E-01 | 0.14570E 01 |
| 4 | 40 | 0.60 | 35.26554 | -0.21780E-01 | 0.14765E 01 |

HYDRONAUTICS, Incorporated

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| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 5 | 1 | 0.60 | 18.87743 | 0.11608E 01 | -0.49892E-04 |
| 5 | 2 | 0.60 | 18.92525 | -0.66069E 00 | -0.29973E-03 |
| 5 | 3 | 0.60 | 19.00475 | 0.25586E 01 | 0.30436E-03 |
| 5 | 4 | 0.60 | 19.11558 | -0.78739E-01 | 0.15238E-02 |
| 5 | 5 | 0.60 | 19.25722 | -0.32750E 01 | 0.72546E-03 |
| 5 | 6 | 0.60 | 19.42909 | 0.93174E 00 | -0.27185E-02 |
| 5 | 7 | 0.60 | 19.63048 | -0.29924E 00 | -0.50363E-02 |
| 5 | 8 | 0.60 | 19.86057 | -0.30938E 01 | -0.22225E-02 |
| 5 | 9 | 0.60 | 20.11865 | 0.15122E 01 | 0.53429E-02 |
| 5 | 10 | 0.60 | 20.40363 | 0.15807E 00 | 0.12524E-01 |
| 5 | 11 | 0.60 | 20.71472 | -0.69743E 00 | 0.13477E-01 |
| 5 | 12 | 0.60 | 21.05089 | -0.38111E 01 | 0.53119E-02 |
| 5 | 13 | 0.60 | 21.41118 | 0.24236E 01 | -0.10075E-01 |
| 5 | 14 | 0.60 | 21.79465 | 0.66315E 00 | -0.27597E-01 |
| 5 | 15 | 0.60 | 22.20044 | 0.42571E-01 | -0.41178E-01 |
| 5 | 16 | 0.60 | 22.62752 | -0.48639E 00 | -0.45806E-01 |
| 5 | 17 | 0.60 | 23.07510 | -0.12680E 01 | -0.38759E-01 |
| 5 | 18 | 0.60 | 23.54246 | -0.37632E 01 | -0.19670E-01 |
| 5 | 19 | 0.60 | 24.02883 | 0.91758E 01 | 0.10108E-01 |
| 5 | 20 | 0.60 | 24.53371 | 0.21280E 01 | 0.48146E-01 |
| 5 | 21 | 0.60 | 25.05630 | 0.11068E 01 | 0.91658E-01 |
| 5 | 22 | 0.60 | 25.59628 | 0.64695E 00 | 0.13804E 00 |
| 5 | 23 | 0.60 | 26.15326 | 0.35855E 00 | 0.18526E 00 |
| 5 | 24 | 0.60 | 26.72694 | 0.14578E 00 | 0.23186E 00 |
| 5 | 25 | 0.60 | 27.31711 | -0.25569E-01 | 0.27724E 00 |
| 5 | 26 | 0.60 | 27.92350 | -0.16949E 00 | 0.32136E 00 |
| 5 | 27 | 0.60 | 28.54588 | -0.29117E 00 | 0.36489E 00 |
| 5 | 28 | 0.60 | 29.18406 | -0.39130E 00 | 0.40903E 00 |
| 5 | 29 | 0.60 | 29.83753 | -0.46851E 00 | 0.45509E 00 |
| 5 | 30 | 0.60 | 30.50561 | -0.52102E 00 | 0.50455E 00 |
| 5 | 31 | 0.60 | 31.18738 | -0.54816E 00 | 0.55860E 00 |
| 5 | 32 | 0.60 | 31.88135 | -0.55125E 00 | 0.61789E 00 |
| 5 | 33 | 0.60 | 32.58574 | -0.53360E 00 | 0.68235E 00 |
| 5 | 34 | 0.60 | 33.29853 | -0.49993E 00 | 0.75115E 00 |
| 5 | 35 | 0.60 | 34.01739 | -0.45539E 00 | 0.82281E 00 |
| 5 | 36 | 0.60 | 34.74006 | -0.40482E 00 | 0.89539E 00 |
| 5 | 37 | 0.60 | 35.46424 | -0.35218E 00 | 0.96677E 00 |
| 5 | 38 | 0.60 | 36.18791 | -0.30053E 00 | 0.10348E 01 |
| 5 | 39 | 0.60 | 36.90938 | -0.25197E 00 | 0.10980E 01 |
| 5 | 40 | 0.60 | 37.62746 | -0.20788E 00 | 0.11548E 01 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 6 | 1 | 0.60 | 23.58420 | -0.88777E 00 | -0.20713E-03 |
| 6 | 2 | 0.60 | 23.62247 | 0.13885E 01 | 0.26632E-03 |
| 6 | 3 | 0.60 | 23.68610 | -0.48905E 00 | 0.74564E-03 |
| 6 | 4 | 0.60 | 23.77491 | 0.44972E 01 | -0.29765E-03 |
| 6 | 5 | 0.60 | 23.88868 | 0.83337E-01 | -0.20722E-02 |
| 6 | 6 | 0.60 | 24.02706 | -0.20713E 01 | -0.12900E-02 |
| 6 | 7 | 0.60 | 24.18968 | 0.12090E 01 | 0.25611E-02 |
| 6 | 8 | 0.60 | 24.37606 | -0.20202E 00 | 0.51858E-02 |
| 6 | 9 | 0.60 | 24.58585 | -0.27183E 01 | 0.23293E-02 |
| 6 | 10 | 0.60 | 24.81843 | 0.14362E 01 | -0.48423E-02 |
| 6 | 11 | 0.60 | 25.07331 | 0.58193E-01 | -0.10443E-01 |
| 6 | 12 | 0.60 | 25.34989 | -0.10134E 01 | -0.89123E-02 |
| 6 | 13 | 0.60 | 25.64746 | 0.51384E 02 | 0.29795E-03 |
| 6 | 14 | 0.60 | 25.96555 | 0.10362E 01 | 0.12686E-01 |
| 6 | 15 | 0.60 | 26.30354 | 0.10330E 00 | 0.21572E-01 |
| 6 | 16 | 0.60 | 26.66062 | -0.61547E 00 | 0.21777E-01 |
| 6 | 17 | 0.60 | 27.03639 | -0.23128E 01 | 0.11939E-01 |
| 6 | 18 | 0.60 | 27.43017 | 0.61444E 01 | -0.56540E-02 |
| 6 | 19 | 0.60 | 27.84126 | 0.12084E 01 | -0.26234E-01 |
| 6 | 20 | 0.60 | 28.26925 | 0.40782E 00 | -0.44426E-01 |
| 6 | 21 | 0.60 | 28.71353 | -0.69365E-01 | -0.55738E-01 |
| 6 | 22 | 0.60 | 29.17351 | -0.53565E 00 | -0.57302E-01 |
| 6 | 23 | 0.60 | 29.64879 | -0.12142E 01 | -0.48074E-01 |
| 6 | 24 | 0.60 | 30.13896 | -0.29226E 01 | -0.28443E-01 |
| 6 | 25 | 0.60 | 30.64356 | 0.59696E 04 | 0.17105E-04 |
| 6 | 26 | 0.60 | 31.16227 | 0.32108E 01 | 0.35251E-01 |
| 6 | 27 | 0.60 | 31.69467 | 0.15369E 01 | 0.75086E-01 |
| 6 | 28 | 0.60 | 32.24060 | 0.92204E 00 | 0.11748E 00 |
| 6 | 29 | 0.60 | 32.79988 | 0.57337E 00 | 0.16075E 00 |
| 6 | 30 | 0.60 | 33.37236 | 0.33181E 00 | 0.20362E 00 |
| 6 | 31 | 0.60 | 33.95793 | 0.14441E 00 | 0.24545E 00 |
| 6 | 32 | 0.60 | 34.55650 | -0.10912E-01 | 0.28596E 00 |
| 6 | 33 | 0.60 | 35.16815 | -0.14411E 00 | 0.32525E 00 |
| 6 | 34 | 0.60 | 35.79281 | -0.25936E 00 | 0.36403E 00 |
| 6 | 35 | 0.60 | 36.43046 | -0.35752E 00 | 0.40312E 00 |
| 6 | 36 | 0.60 | 37.08090 | -0.43763E 00 | 0.44376E 00 |
| 6 | 37 | 0.60 | 37.74403 | -0.49794E 00 | 0.48698E 00 |
| 6 | 38 | 0.60 | 38.41925 | -0.53706E 00 | 0.53402E 00 |
| 6 | 39 | 0.60 | 39.10578 | -0.55472E 00 | 0.58572E 00 |
| 6 | 40 | 0.60 | 39.80249 | -0.55221E 00 | 0.64239E 00 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|-------------|
| 1 | 1 | 0.70 | 0.82759 | -0.34809E 00 | 0.70206E 00 |
| 1 | 2 | 0.70 | 1.65389 | -0.36706E 00 | 0.86191E 00 |
| 1 | 3 | 0.70 | 2.47768 | -0.34479E 00 | 0.10081E 01 |
| 1 | 4 | 0.70 | 3.29755 | -0.30938E 00 | 0.11512E 01 |
| 1 | 5 | 0.70 | 4.11242 | -0.26988E 00 | 0.12946E 01 |
| 1 | 6 | 0.70 | 4.92115 | -0.23030E 00 | 0.14389E 01 |
| 1 | 7 | 0.70 | 5.72299 | -0.19286E 00 | 0.15831E 01 |
| 1 | 8 | 0.70 | 6.51722 | -0.15874E 00 | 0.17257E 01 |
| 1 | 9 | 0.70 | 7.30346 | -0.12857E 00 | 0.18646E 01 |
| 1 | 10 | 0.70 | 8.08169 | -0.10259E 00 | 0.19976E 01 |
| 1 | 11 | 0.70 | 8.85216 | -0.80749E-01 | 0.21229E 01 |
| 1 | 12 | 0.70 | 9.61533 | -0.62777E-01 | 0.22394E 01 |
| 1 | 13 | 0.70 | 10.37179 | -0.48272E-01 | 0.23463E 01 |
| 1 | 14 | 0.70 | 11.12246 | -0.36777E-01 | 0.24438E 01 |
| 1 | 15 | 0.70 | 11.86793 | -0.27790E-01 | 0.25323E 01 |
| 1 | 16 | 0.70 | 12.60900 | -0.20856E-01 | 0.26127E 01 |
| 1 | 17 | 0.70 | 13.34637 | -0.15564E-01 | 0.26862E 01 |
| 1 | 18 | 0.70 | 14.08064 | -0.11559E-01 | 0.27536E 01 |
| 1 | 19 | 0.70 | 14.81241 | -0.85520E-02 | 0.28157E 01 |
| 1 | 20 | 0.70 | 15.54208 | -0.63063E-02 | 0.28737E 01 |
| 1 | 21 | 0.70 | 16.26996 | -0.46375E-02 | 0.29281E 01 |
| 1 | 22 | 0.70 | 16.99623 | -0.34014E-02 | 0.29796E 01 |
| 1 | 23 | 0.70 | 17.72140 | -0.24905E-02 | 0.30286E 01 |
| 1 | 24 | 0.70 | 18.44538 | -0.18198E-02 | 0.30755E 01 |
| 1 | 25 | 0.70 | 19.16846 | -0.13277E-02 | 0.31207E 01 |
| 1 | 26 | 0.70 | 19.89073 | -0.96740E-03 | 0.31643E 01 |
| 1 | 27 | 0.70 | 20.61230 | -0.70397E-03 | 0.32065E 01 |
| 1 | 28 | 0.70 | 21.33318 | -0.51163E-03 | 0.32476E 01 |
| 1 | 29 | 0.70 | 22.05356 | -0.37149E-03 | 0.32876E 01 |
| 1 | 30 | 0.70 | 22.77333 | -0.26943E-03 | 0.33267E 01 |
| 1 | 31 | 0.70 | 23.49270 | -0.19526E-03 | 0.33647E 01 |
| 1 | 32 | 0.70 | 24.21157 | -0.14137E-03 | 0.34020E 01 |
| 1 | 33 | 0.70 | 24.93004 | -0.10227E-03 | 0.34385E 01 |
| 1 | 34 | 0.70 | 25.64812 | -0.73928E-04 | 0.34743E 01 |
| 1 | 35 | 0.70 | 26.36589 | -0.53405E-04 | 0.35093E 01 |
| 1 | 36 | 0.70 | 27.08326 | -0.38549E-04 | 0.35437E 01 |
| 1 | 37 | 0.70 | 27.80034 | -0.27808E-04 | 0.35775E 01 |
| 1 | 38 | 0.70 | 28.51711 | -0.20047E-04 | 0.36106E 01 |
| 1 | 39 | 0.70 | 29.23348 | -0.14441E-04 | 0.36433E 01 |
| 1 | 40 | 0.70 | 29.94966 | -0.10397E-04 | 0.36754E 01 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 2 | 1 | 0.70 | 7.41429 | -0.19953E 01 | 0.30669E-02 |
| 2 | 2 | 0.70 | 7.55917 | 0.10515E 01 | -0.18774E-01 |
| 2 | 3 | 0.70 | 7.79534 | -0.20402E 00 | -0.59749E-01 |
| 2 | 4 | 0.70 | 8.11601 | -0.16375E 01 | -0.55954E-01 |
| 2 | 5 | 0.70 | 8.51263 | 0.91495E 01 | 0.17999E-01 |
| 2 | 6 | 0.70 | 8.97675 | 0.13782E 01 | 0.13764E 00 |
| 2 | 7 | 0.70 | 9.49996 | 0.59738E 00 | 0.26749E 00 |
| 2 | 8 | 0.70 | 10.07426 | 0.23094E 00 | 0.38494E 00 |
| 2 | 9 | 0.70 | 10.69285 | -0.89683E-02 | 0.48199E 00 |
| 2 | 10 | 0.70 | 11.34923 | -0.18607E 00 | 0.56027E 00 |
| 2 | 11 | 0.70 | 12.03780 | -0.32024E 00 | 0.62516E 00 |
| 2 | 12 | 0.70 | 12.75348 | -0.41874E 00 | 0.68249E 00 |
| 2 | 13 | 0.70 | 13.49165 | -0.48531E 00 | 0.73739E 00 |
| 2 | 14 | 0.70 | 14.24831 | -0.52344E 00 | 0.79315E 00 |
| 2 | 15 | 0.70 | 15.01988 | -0.53737E 00 | 0.85191E 00 |
| 2 | 16 | 0.70 | 15.80304 | -0.53191E 00 | 0.91485E 00 |
| 2 | 17 | 0.70 | 16.59511 | -0.51191E 00 | 0.98209E 00 |
| 2 | 18 | 0.70 | 17.39366 | -0.48177E 00 | 0.10533E 01 |
| 2 | 19 | 0.70 | 18.19642 | -0.44518E 00 | 0.11281E 01 |
| 2 | 20 | 0.70 | 19.00168 | -0.40508E 00 | 0.12055E 01 |
| 2 | 21 | 0.70 | 19.80774 | -0.36369E 00 | 0.12847E 01 |
| 2 | 22 | 0.70 | 20.61330 | -0.32262E 00 | 0.13646E 01 |
| 2 | 23 | 0.70 | 21.41726 | -0.28307E 00 | 0.14440E 01 |
| 2 | 24 | 0.70 | 22.21872 | -0.24582E 00 | 0.15219E 01 |
| 2 | 25 | 0.70 | 23.01688 | -0.21141E 00 | 0.15973E 01 |
| 2 | 26 | 0.70 | 23.81124 | -0.18012E 00 | 0.16695E 01 |
| 2 | 27 | 0.70 | 24.60161 | -0.15214E 00 | 0.17376E 01 |
| 2 | 28 | 0.70 | 25.38777 | -0.12744E 00 | 0.18011E 01 |
| 2 | 29 | 0.70 | 26.16964 | -0.10592E 00 | 0.18600E 01 |
| 2 | 30 | 0.70 | 26.94740 | -0.87394E-01 | 0.19141E 01 |
| 2 | 31 | 0.70 | 27.72137 | -0.71638E-01 | 0.19633E 01 |
| 2 | 32 | 0.70 | 28.49163 | -0.58359E-01 | 0.20083E 01 |
| 2 | 33 | 0.70 | 29.25860 | -0.47279E-01 | 0.20493E 01 |
| 2 | 34 | 0.70 | 30.02247 | -0.38106E-01 | 0.20868E 01 |
| 2 | 35 | 0.70 | 30.78374 | -0.30575E-01 | 0.21211E 01 |
| 2 | 36 | 0.70 | 31.54250 | -0.24428E-01 | 0.21528E 01 |
| 2 | 37 | 0.70 | 32.29916 | -0.19444E-01 | 0.21821E 01 |
| 2 | 38 | 0.70 | 33.05394 | -0.15424E-01 | 0.22096E 01 |
| 2 | 39 | 0.70 | 33.80693 | -0.12196E-01 | 0.22355E 01 |
| 2 | 40 | 0.70 | 34.55851 | -0.96164E-02 | 0.22600E 01 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 3 | 1 | 0.70 | 14.70251 | -0.16181E 00 | 0.19690E-03 |
| 3 | 2 | 0.70 | 14.77444 | -0.74727E 02 | 0.14330E-04 |
| 3 | 3 | 0.70 | 14.89348 | 0.30998E 00 | -0.24364E-02 |
| 3 | 4 | 0.70 | 15.05871 | -0.11924E 01 | -0.30359E-02 |
| 3 | 5 | 0.70 | 15.26863 | 0.25768E 01 | 0.27932E-02 |
| 3 | 6 | 0.70 | 15.52166 | 0.23702E 00 | 0.11409E-01 |
| 3 | 7 | 0.70 | 15.81592 | -0.74613E 00 | 0.13612E-01 |
| 3 | 8 | 0.70 | 16.14932 | -0.69091E 01 | 0.33958E-02 |
| 3 | 9 | 0.70 | 16.51976 | 0.15909E 01 | -0.17109E-01 |
| 3 | 10 | 0.70 | 16.92502 | 0.39854E 00 | -0.39603E-01 |
| 3 | 11 | 0.70 | 17.36303 | -0.18499E 00 | -0.54484E-01 |
| 3 | 12 | 0.70 | 17.83171 | -0.81360E 00 | -0.55024E-01 |
| 3 | 13 | 0.70 | 18.32906 | -0.21012E 01 | -0.38451E-01 |
| 3 | 14 | 0.70 | 18.85323 | -0.19316E 02 | -0.57587E-02 |
| 3 | 15 | 0.70 | 19.40253 | 0.32983E 01 | 0.39770E-01 |
| 3 | 16 | 0.70 | 19.97536 | 0.14665E 01 | 0.93965E-01 |
| 3 | 17 | 0.70 | 20.57019 | 0.85310E 00 | 0.15270E 00 |
| 3 | 18 | 0.70 | 21.18582 | 0.51410E 00 | 0.21264E 00 |
| 3 | 19 | 0.70 | 21.82098 | 0.28201E 00 | 0.27137E 00 |
| 3 | 20 | 0.70 | 22.47462 | 0.10394E 00 | 0.32742E 00 |
| 3 | 21 | 0.70 | 23.14565 | -0.41611E-01 | 0.38016E 00 |
| 3 | 22 | 0.70 | 23.83313 | -0.16431E 00 | 0.42970E 00 |
| 3 | 23 | 0.70 | 24.53608 | -0.26852E 00 | 0.47666E 00 |
| 3 | 24 | 0.70 | 25.25362 | -0.35589E 00 | 0.52190E 00 |
| 3 | 25 | 0.70 | 25.98469 | -0.42689E 00 | 0.56653E 00 |
| 3 | 26 | 0.70 | 26.72827 | -0.48151E 00 | 0.61162E 00 |
| 3 | 27 | 0.70 | 27.48329 | -0.51992E 00 | 0.65808E 00 |
| 3 | 28 | 0.70 | 28.24863 | -0.54275E 00 | 0.70675E 00 |
| 3 | 29 | 0.70 | 29.02302 | -0.55125E 00 | 0.75806E 00 |
| 3 | 30 | 0.70 | 29.80529 | -0.54717E 00 | 0.81227E 00 |
| 3 | 31 | 0.70 | 30.59415 | -0.53262E 00 | 0.86937E 00 |
| 3 | 32 | 0.70 | 31.38840 | -0.50982E 00 | 0.92911E 00 |
| 3 | 33 | 0.70 | 32.18678 | -0.48093E 00 | 0.99103E 00 |
| 3 | 34 | 0.70 | 32.98816 | -0.44788E 00 | 0.10546E 01 |
| 3 | 35 | 0.70 | 33.79142 | -0.41236E 00 | 0.11191E 01 |
| 3 | 36 | 0.70 | 34.59556 | -0.37576E 00 | 0.11839E 01 |
| 3 | 37 | 0.70 | 35.39966 | -0.33916E 00 | 0.12482E 01 |
| 3 | 38 | 0.70 | 36.20294 | -0.30344E 00 | 0.13112E 01 |
| 3 | 39 | 0.70 | 37.00468 | -0.26924E 00 | 0.13723E 01 |
| 3 | 40 | 0.70 | 37.80433 | -0.23702E 00 | 0.14307E 01 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 4 | 1 | 0.70 | 22.01898 | 0.11452E 01 | 0.16408E-03 |
| 4 | 2 | 0.70 | 22.06676 | -0.68698E 00 | 0.59347E-03 |
| 4 | 3 | 0.70 | 22.14624 | 0.23040E 01 | -0.62188E-03 |
| 4 | 4 | 0.70 | 22.25711 | -0.14241E 00 | -0.26617E-02 |
| 4 | 5 | 0.70 | 22.39878 | -0.49203E 01 | -0.83602E-03 |
| 4 | 6 | 0.70 | 22.57095 | 0.70627E 00 | 0.49328E-02 |
| 4 | 7 | 0.70 | 22.77271 | -0.50971E 00 | 0.73747E-02 |
| 4 | 8 | 0.70 | 23.00347 | -0.12321E 02 | 0.87863E-03 |
| 4 | 9 | 0.70 | 23.26242 | 0.84002E 00 | -0.10655E-01 |
| 4 | 10 | 0.70 | 23.54867 | -0.19427E 00 | -0.17061E-01 |
| 4 | 11 | 0.70 | 23.86131 | -0.16381E 01 | -0.11110E-01 |
| 4 | 12 | 0.70 | 24.19935 | 0.43494E 01 | 0.57744E-02 |
| 4 | 13 | 0.70 | 24.56198 | 0.72104E 00 | 0.24958E-01 |
| 4 | 14 | 0.70 | 24.94801 | -0.44596E-01 | 0.36310E-01 |
| 4 | 15 | 0.70 | 25.35663 | -0.78537E 00 | 0.33558E-01 |
| 4 | 16 | 0.70 | 25.78696 | -0.29275E 01 | 0.16048E-01 |
| 4 | 17 | 0.70 | 26.23778 | 0.48253E 01 | -0.11670E-01 |
| 4 | 18 | 0.70 | 26.70839 | 0.11922E 01 | -0.42587E-01 |
| 4 | 19 | 0.70 | 27.19790 | 0.44254E 00 | -0.69520E-01 |
| 4 | 20 | 0.70 | 27.70541 | -0.46155E-02 | -0.86948E-01 |
| 4 | 21 | 0.70 | 28.23011 | -0.41472E 00 | -0.91538E-01 |
| 4 | 22 | 0.70 | 28.77122 | -0.93355E 00 | -0.82380E-01 |
| 4 | 23 | 0.70 | 29.32812 | -0.18722E 01 | -0.60233E-01 |
| 4 | 24 | 0.70 | 29.90003 | -0.52510E 01 | -0.27079E-01 |
| 4 | 25 | 0.70 | 30.48642 | 0.11207E 02 | 0.14532E-01 |
| 4 | 26 | 0.70 | 31.08662 | 0.28037E 01 | 0.61935E-01 |
| 4 | 27 | 0.70 | 31.70021 | 0.15464E 01 | 0.11266E 00 |
| 4 | 28 | 0.70 | 32.32658 | 0.10016E 01 | 0.16462E 00 |
| 4 | 29 | 0.70 | 32.96543 | 0.67727E 00 | 0.21621E 00 |
| 4 | 30 | 0.70 | 33.61627 | 0.45014E 00 | 0.26627E 00 |
| 4 | 31 | 0.70 | 34.27870 | 0.27478E 00 | 0.31407E 00 |
| 4 | 32 | 0.70 | 34.95252 | 0.13077E 00 | 0.35929E 00 |
| 4 | 33 | 0.70 | 35.63735 | 0.76936E-02 | 0.40183E 00 |
| 4 | 34 | 0.70 | 36.33286 | -0.99974E-01 | 0.44207E 00 |
| 4 | 35 | 0.70 | 37.03887 | -0.19510E 00 | 0.48028E 00 |
| 4 | 36 | 0.70 | 37.75497 | -0.27909E 00 | 0.51717E 00 |
| 4 | 37 | 0.70 | 38.48097 | -0.35233E 00 | 0.55331E 00 |
| 4 | 38 | 0.70 | 39.21636 | -0.41477E 00 | 0.58948E 00 |
| 4 | 39 | 0.70 | 39.96095 | -0.46603E 00 | 0.62638E 00 |
| 4 | 40 | 0.70 | 40.71403 | -0.50583E 00 | 0.66473E 00 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 5 | 1 | 0.70 | 29.34234 | -0.30957E 01 | 0.11568E-04 |
| 5 | 2 | 0.70 | 29.37823 | 0.42212E 00 | 0.68702E-04 |
| 5 | 3 | 0.70 | 29.43791 | -0.16529E 01 | 0.85392E-04 |
| 5 | 4 | 0.70 | 29.52119 | 0.92390E 00 | -0.24814E-03 |
| 5 | 5 | 0.70 | 29.62796 | -0.63608E 00 | -0.49700E-03 |
| 5 | 6 | 0.70 | 29.75794 | 0.38782E 01 | 0.21858E-03 |
| 5 | 7 | 0.70 | 29.91091 | 0.11728E 00 | 0.12636E-02 |
| 5 | 8 | 0.70 | 30.08648 | -0.16696E 01 | 0.87729E-03 |
| 5 | 9 | 0.70 | 30.28433 | 0.16106E 01 | -0.11934E-02 |
| 5 | 10 | 0.70 | 30.50399 | -0.28818E-01 | -0.28880E-02 |
| 5 | 11 | 0.70 | 30.74505 | -0.16387E 01 | -0.18777E-02 |
| 5 | 12 | 0.70 | 31.00710 | 0.23804E 01 | 0.17248E-02 |
| 5 | 13 | 0.70 | 31.28945 | 0.28133E 00 | 0.51918E-02 |
| 5 | 14 | 0.70 | 31.59180 | -0.65412E 00 | 0.54202E-02 |
| 5 | 15 | 0.70 | 31.91353 | -0.54440E 01 | 0.14034E-02 |
| 5 | 16 | 0.70 | 32.25418 | 0.15059E 01 | -0.50629E-02 |
| 5 | 17 | 0.70 | 32.61308 | 0.26292E 00 | -0.10430E-01 |
| 5 | 18 | 0.70 | 32.98977 | -0.46070E 00 | -0.11486E-01 |
| 5 | 19 | 0.70 | 33.38365 | -0.18871E 01 | -0.69341E-02 |
| 5 | 20 | 0.70 | 33.79422 | 0.77055E 01 | 0.22106E-02 |
| 5 | 21 | 0.70 | 34.22088 | 0.11597E 01 | 0.12947E-01 |
| 5 | 22 | 0.70 | 34.66304 | 0.31913E 00 | 0.21747E-01 |
| 5 | 23 | 0.70 | 35.12038 | -0.21366E 00 | 0.25690E-01 |
| 5 | 24 | 0.70 | 35.59222 | -0.84338E 00 | 0.22977E-01 |
| 5 | 25 | 0.70 | 36.07815 | -0.23135E 01 | 0.13630E-01 |
| 5 | 26 | 0.70 | 36.57767 | 0.36204E 02 | -0.10812E-02 |
| 5 | 27 | 0.70 | 37.09018 | 0.21352E 01 | -0.18862E-01 |
| 5 | 28 | 0.70 | 37.61539 | 0.92505E 00 | -0.37041E-01 |
| 5 | 29 | 0.70 | 38.15289 | 0.40299E 00 | -0.53058E-01 |
| 5 | 30 | 0.70 | 38.70208 | 0.41382E-01 | -0.64578E-01 |
| 5 | 31 | 0.70 | 39.26277 | -0.28715E 00 | -0.70158E-01 |
| 5 | 32 | 0.70 | 39.83446 | -0.65654E 00 | -0.68794E-01 |
| 5 | 33 | 0.70 | 40.41683 | -0.11699E 01 | -0.60191E-01 |
| 5 | 34 | 0.70 | 41.00961 | -0.21102E 01 | -0.44589E-01 |
| 5 | 35 | 0.70 | 41.61238 | -0.50679E 01 | -0.22620E-01 |
| 5 | 36 | 0.70 | 42.22493 | 0.27274E 02 | 0.47971E-02 |
| 5 | 37 | 0.70 | 42.84699 | 0.38744E 01 | 0.36619E-01 |
| 5 | 38 | 0.70 | 43.47824 | 0.20506E 01 | 0.71776E-01 |
| 5 | 39 | 0.70 | 44.11858 | 0.13414E 01 | 0.10924E 00 |
| 5 | 40 | 0.70 | 44.76772 | 0.94461E 00 | 0.14805E 00 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 6 | 1 | 0.70 | 36.66853 | -0.22500E 00 | -0.19411E-03 |
| 6 | 2 | 0.70 | 36.69721 | 0.65394E 01 | 0.49519E-04 |
| 6 | 3 | 0.70 | 36.74497 | -0.35931E-01 | 0.38139E-03 |
| 6 | 4 | 0.70 | 36.81173 | -0.79014E 01 | 0.76473E-04 |
| 6 | 5 | 0.70 | 36.89728 | 0.34618E 00 | -0.85026E-03 |
| 6 | 6 | 0.70 | 37.00172 | -0.15064E 01 | -0.62663E-03 |
| 6 | 7 | 0.70 | 37.12465 | 0.12181E 01 | 0.97645E-03 |
| 6 | 8 | 0.70 | 37.26607 | -0.36018E 00 | 0.18699E-02 |
| 6 | 9 | 0.70 | 37.42578 | -0.25289E 02 | 0.95917E-04 |
| 6 | 10 | 0.70 | 37.60347 | 0.50493E 00 | -0.26658E-02 |
| 6 | 11 | 0.70 | 37.79896 | -0.73383E 00 | -0.29054E-02 |
| 6 | 12 | 0.70 | 38.01204 | 0.81814E 01 | 0.52207E-03 |
| 6 | 13 | 0.70 | 38.24221 | 0.45867E 00 | 0.45687E-02 |
| 6 | 14 | 0.70 | 38.48947 | -0.61246E 00 | 0.50072E-02 |
| 6 | 15 | 0.70 | 38.75333 | -0.12455E 02 | 0.54186E-03 |
| 6 | 16 | 0.70 | 39.03347 | 0.92638E 00 | -0.56776E-02 |
| 6 | 17 | 0.70 | 39.32971 | -0.12054E 00 | -0.87199E-02 |
| 6 | 18 | 0.70 | 39.64154 | -0.14036E 01 | -0.57530E-02 |
| 6 | 19 | 0.70 | 39.96875 | 0.55464E 01 | 0.19770E-02 |
| 6 | 20 | 0.70 | 40.31096 | 0.72659E 00 | 0.10088E-01 |
| 6 | 21 | 0.70 | 40.66766 | -0.10395E 00 | 0.13841E-01 |
| 6 | 22 | 0.70 | 41.03875 | -0.10383E 01 | 0.10732E-01 |
| 6 | 23 | 0.70 | 41.42374 | -0.10381E 02 | 0.16378E-02 |
| 6 | 24 | 0.70 | 41.82231 | 0.16480E 01 | -0.98058E-02 |
| 6 | 25 | 0.70 | 42.23409 | 0.43703E 00 | -0.19056E-01 |
| 6 | 26 | 0.70 | 42.65875 | -0.17610E 00 | -0.22505E-01 |
| 6 | 27 | 0.70 | 43.09590 | -0.90328E 00 | -0.18667E-01 |
| 6 | 28 | 0.70 | 43.54525 | -0.32219E 01 | -0.81746E-02 |
| 6 | 29 | 0.70 | 44.00640 | 0.46869E 01 | 0.62901E-02 |
| 6 | 30 | 0.70 | 44.47914 | 0.11918E 01 | 0.21219E-01 |
| 6 | 31 | 0.70 | 44.96307 | 0.43118E 00 | 0.33060E-01 |
| 6 | 32 | 0.70 | 45.45790 | -0.37089E-01 | 0.39323E-01 |
| 6 | 33 | 0.70 | 45.96321 | -0.49635E 00 | 0.38420E-01 |
| 6 | 34 | 0.70 | 46.47893 | -0.11722E 01 | 0.30363E-01 |
| 6 | 35 | 0.70 | 47.00453 | -0.30036E 01 | 0.16116E-01 |
| 6 | 36 | 0.70 | 47.53993 | 0.22108E 02 | -0.25106E-02 |
| 6 | 37 | 0.70 | 48.08483 | 0.24036E 01 | -0.23234E-01 |
| 6 | 38 | 0.70 | 48.63883 | 0.11252E 01 | -0.43769E-01 |
| 6 | 39 | 0.70 | 49.20191 | 0.58354E 00 | -0.61959E-01 |
| 6 | 40 | 0.70 | 49.77360 | 0.23168E 00 | -0.76088E-01 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|-------------|
| 1 | 1 | 0.80 | 0.89059 | -0.36360E 00 | 0.69048E 00 |
| 1 | 2 | 0.80 | 1.78109 | -0.40921E 00 | 0.82564E 00 |
| 1 | 3 | 0.80 | 2.67118 | -0.41570E 00 | 0.93783E 00 |
| 1 | 4 | 0.80 | 3.56055 | -0.40795E 00 | 0.10396E 01 |
| 1 | 5 | 0.80 | 4.44900 | -0.39326E 00 | 0.11362E 01 |
| 1 | 6 | 0.80 | 5.33643 | -0.37481E 00 | 0.12301E 01 |
| 1 | 7 | 0.80 | 6.22256 | -0.35423E 00 | 0.13228E 01 |
| 1 | 8 | 0.80 | 7.10719 | -0.33252E 00 | 0.14150E 01 |
| 1 | 9 | 0.80 | 7.99012 | -0.31034E 00 | 0.15073E 01 |
| 1 | 10 | 0.80 | 8.87117 | -0.28814E 00 | 0.15999E 01 |
| 1 | 11 | 0.80 | 9.75012 | -0.26623E 00 | 0.16929E 01 |
| 1 | 12 | 0.80 | 10.62687 | -0.24488E 00 | 0.17862E 01 |
| 1 | 13 | 0.80 | 11.50121 | -0.22425E 00 | 0.18797E 01 |
| 1 | 14 | 0.80 | 12.37296 | -0.20446E 00 | 0.19733E 01 |
| 1 | 15 | 0.80 | 13.24221 | -0.18567E 00 | 0.20664E 01 |
| 1 | 16 | 0.80 | 14.10865 | -0.16791E 00 | 0.21590E 01 |
| 1 | 17 | 0.80 | 14.97230 | -0.15125E 00 | 0.22506E 01 |
| 1 | 18 | 0.80 | 15.83316 | -0.13571E 00 | 0.23408E 01 |
| 1 | 19 | 0.80 | 16.69111 | -0.12130E 00 | 0.24293E 01 |
| 1 | 20 | 0.80 | 17.54636 | -0.10803E 00 | 0.25157E 01 |
| 1 | 21 | 0.80 | 18.39871 | -0.95865E-01 | 0.25997E 01 |
| 1 | 22 | 0.80 | 19.24836 | -0.84782E-01 | 0.26811E 01 |
| 1 | 23 | 0.80 | 20.09542 | -0.74740E-01 | 0.27595E 01 |
| 1 | 24 | 0.80 | 20.93997 | -0.65690E-01 | 0.28347E 01 |
| 1 | 25 | 0.80 | 21.78202 | -0.57563E-01 | 0.29069E 01 |
| 1 | 26 | 0.80 | 22.62188 | -0.50312E-01 | 0.29758E 01 |
| 1 | 27 | 0.80 | 23.45953 | -0.43861E-01 | 0.30415E 01 |
| 1 | 28 | 0.80 | 24.29518 | -0.38148E-01 | 0.31040E 01 |
| 1 | 29 | 0.80 | 25.12894 | -0.33107E-01 | 0.31635E 01 |
| 1 | 30 | 0.80 | 25.96099 | -0.28677E-01 | 0.32200E 01 |
| 1 | 31 | 0.80 | 26.79145 | -0.24795E-01 | 0.32737E 01 |
| 1 | 32 | 0.80 | 27.62041 | -0.21401E-01 | 0.33248E 01 |
| 1 | 33 | 0.80 | 28.44796 | -0.18443E-01 | 0.33735E 01 |
| 1 | 34 | 0.80 | 29.27441 | -0.15874E-01 | 0.34199E 01 |
| 1 | 35 | 0.80 | 30.09967 | -0.13645E-01 | 0.34642E 01 |
| 1 | 36 | 0.80 | 30.92393 | -0.11716E-01 | 0.35065E 01 |
| 1 | 37 | 0.80 | 31.74728 | -0.10049E-01 | 0.35471E 01 |
| 1 | 38 | 0.80 | 32.56973 | -0.86107E-02 | 0.35862E 01 |
| 1 | 39 | 0.80 | 33.39147 | -0.73724E-02 | 0.36237E 01 |
| 1 | 40 | 0.80 | 34.21252 | -0.63071E-02 | 0.36599E 01 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 2 | 1 | 0.80 | 12.62207 | 0.12879E 01 | -0.13292E-02 |
| 2 | 2 | 0.80 | 12.71805 | -0.47786E 00 | -0.77079E-02 |
| 2 | 3 | 0.80 | 12.87642 | 0.10710E 02 | 0.17888E-02 |
| 2 | 4 | 0.80 | 13.09508 | 0.41274E 00 | 0.31533E-01 |
| 2 | 5 | 0.80 | 13.37123 | -0.64277E 00 | 0.44712E-01 |
| 2 | 6 | 0.80 | 13.70157 | -0.65818E 01 | 0.11471E-01 |
| 2 | 7 | 0.80 | 14.08250 | 0.14799E 01 | -0.58024E-01 |
| 2 | 8 | 0.80 | 14.51043 | 0.33695E 00 | -0.12782E 00 |
| 2 | 9 | 0.80 | 14.98145 | -0.24832E 00 | -0.16496E 00 |
| 2 | 10 | 0.80 | 15.49216 | -0.90944E 00 | -0.15438E 00 |
| 2 | 11 | 0.80 | 16.03876 | -0.23465E 01 | -0.98379E-01 |
| 2 | 12 | 0.80 | 16.61835 | -0.33467E 02 | -0.88465E-02 |
| 2 | 13 | 0.80 | 17.22764 | 0.33082E 01 | 0.99697E-01 |
| 2 | 14 | 0.80 | 17.86423 | 0.15483E 01 | 0.21449E 00 |
| 2 | 15 | 0.80 | 18.52541 | 0.94148E 00 | 0.32635E 00 |
| 2 | 16 | 0.80 | 19.20899 | 0.60796E 00 | 0.42972E 00 |
| 2 | 17 | 0.80 | 19.91287 | 0.38338E 00 | 0.52193E 00 |
| 2 | 18 | 0.80 | 20.63525 | 0.21439E 00 | 0.60207E 00 |
| 2 | 19 | 0.80 | 21.37451 | 0.78622E-01 | 0.67082E 00 |
| 2 | 20 | 0.80 | 22.12898 | -0.34922E-01 | 0.72963E 00 |
| 2 | 21 | 0.80 | 22.89744 | -0.13195E 00 | 0.78005E 00 |
| 2 | 22 | 0.80 | 23.67861 | -0.21571E 00 | 0.82375E 00 |
| 2 | 23 | 0.80 | 24.47127 | -0.28811E 00 | 0.86247E 00 |
| 2 | 24 | 0.80 | 25.27433 | -0.35030E 00 | 0.89769E 00 |
| 2 | 25 | 0.80 | 26.08679 | -0.40303E 00 | 0.93060E 00 |
| 2 | 26 | 0.80 | 26.90785 | -0.44684E 00 | 0.96229E 00 |
| 2 | 27 | 0.80 | 27.73660 | -0.48225E 00 | 0.99356E 00 |
| 2 | 28 | 0.80 | 28.57226 | -0.50978E 00 | 0.10251E 01 |
| 2 | 29 | 0.80 | 29.41400 | -0.52999E 00 | 0.10576E 01 |
| 2 | 30 | 0.80 | 30.26136 | -0.54346E 00 | 0.10910E 01 |
| 2 | 31 | 0.80 | 31.11361 | -0.55085E 00 | 0.11260E 01 |
| 2 | 32 | 0.80 | 31.97016 | -0.55283E 00 | 0.11625E 01 |
| 2 | 33 | 0.80 | 32.83049 | -0.55006E 00 | 0.12005E 01 |
| 2 | 34 | 0.80 | 33.69412 | -0.54320E 00 | 0.12403E 01 |
| 2 | 35 | 0.80 | 34.56053 | -0.53288E 00 | 0.12818E 01 |
| 2 | 36 | 0.80 | 35.42935 | -0.51968E 00 | 0.13248E 01 |
| 2 | 37 | 0.80 | 36.30027 | -0.50415E 00 | 0.13692E 01 |
| 2 | 38 | 0.80 | 37.17269 | -0.48674E 00 | 0.14151E 01 |
| 2 | 39 | 0.80 | 38.04650 | -0.46793E 00 | 0.14622E 01 |
| 2 | 40 | 0.80 | 38.92132 | -0.44806E 00 | 0.15104E 01 |

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| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 3 | 1 | 0.80 | 25.16056 | 0.11338E 01 | -0.17430E-04 |
| 3 | 2 | 0.80 | 25.20835 | -0.70703E 00 | -0.11564E-03 |
| 3 | 3 | 0.80 | 25.28783 | 0.21404E 01 | 0.19223E-03 |
| 3 | 4 | 0.80 | 25.39870 | -0.19083E 00 | 0.80923E-03 |
| 3 | 5 | 0.80 | 25.54057 | -0.77181E 01 | 0.17494E-03 |
| 3 | 6 | 0.80 | 25.71294 | 0.56425E 00 | -0.17812E-02 |
| 3 | 7 | 0.80 | 25.91510 | -0.69392E 00 | -0.23115E-02 |
| 3 | 8 | 0.80 | 26.14656 | 0.10788E 02 | 0.35540E-03 |
| 3 | 9 | 0.80 | 26.40651 | 0.52482E 00 | 0.44127E-02 |
| 3 | 10 | 0.80 | 26.69406 | -0.48634E 00 | 0.57946E-02 |
| 3 | 11 | 0.80 | 27.00850 | -0.41050E 01 | 0.19120E-02 |
| 3 | 12 | 0.80 | 27.34884 | 0.15062E 01 | -0.55383E-02 |
| 3 | 13 | 0.80 | 27.71417 | 0.21447E 00 | -0.11962E-01 |
| 3 | 14 | 0.80 | 28.10360 | -0.56354E 00 | -0.12928E-01 |
| 3 | 15 | 0.80 | 28.51612 | -0.25070E 01 | -0.66025E-02 |
| 3 | 16 | 0.80 | 28.95074 | 0.38398E 01 | 0.53399E-02 |
| 3 | 17 | 0.80 | 29.40666 | 0.88257E 00 | 0.18790E-01 |
| 3 | 18 | 0.80 | 29.88298 | 0.17076E 00 | 0.29130E-01 |
| 3 | 19 | 0.80 | 30.37859 | -0.36319E 00 | 0.32420E-01 |
| 3 | 20 | 0.80 | 30.89280 | -0.10968E 01 | 0.26956E-01 |
| 3 | 21 | 0.80 | 31.42460 | -0.33733E 01 | 0.13164E-01 |
| 3 | 22 | 0.80 | 31.97330 | 0.74889E 01 | -0.70505E-02 |
| 3 | 23 | 0.80 | 32.53810 | 0.17245E 01 | -0.30579E-01 |
| 3 | 24 | 0.80 | 33.11808 | 0.80676E 00 | -0.54062E-01 |
| 3 | 25 | 0.80 | 33.71276 | 0.35046E 00 | -0.74441E-01 |
| 3 | 26 | 0.80 | 34.32131 | 0.18350E-01 | -0.89378E-01 |
| 3 | 27 | 0.80 | 34.94307 | -0.28636E 00 | -0.96814E-01 |
| 3 | 28 | 0.80 | 35.57742 | -0.62145E 00 | -0.96173E-01 |
| 3 | 29 | 0.80 | 36.22396 | -0.10595E 01 | -0.87046E-01 |
| 3 | 30 | 0.80 | 36.88190 | -0.17636E 01 | -0.69838E-01 |
| 3 | 31 | 0.80 | 37.55072 | -0.33325E 01 | -0.45294E-01 |
| 3 | 32 | 0.80 | 38.23014 | -0.12061E 02 | -0.14448E-01 |
| 3 | 33 | 0.80 | 38.91956 | 0.89187E 01 | 0.21555E-01 |
| 3 | 34 | 0.80 | 39.61857 | 0.33209E 01 | 0.61568E-01 |
| 3 | 35 | 0.80 | 40.32678 | 0.20153E 01 | 0.10441E 00 |
| 3 | 36 | 0.80 | 41.04388 | 0.14104E 01 | 0.14911E 00 |
| 3 | 37 | 0.80 | 41.76937 | 0.10485E 01 | 0.19468E 00 |
| 3 | 38 | 0.80 | 42.50297 | 0.79994E 00 | 0.24043E 00 |
| 3 | 39 | 0.80 | 43.24446 | 0.61350E 00 | 0.28572E 00 |
| 3 | 40 | 0.80 | 43.99344 | 0.46498E 00 | 0.33003E 00 |

HYDRONAUTICS, Incorporated

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| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 4 | 1 | 0.80 | 37.71770 | 0.10872E 01 | -0.10966E-03 |
| 4 | 2 | 0.80 | 37.74953 | -0.79555E 00 | -0.25723E-03 |
| 4 | 3 | 0.80 | 37.80257 | 0.16206E 01 | 0.28941E-03 |
| 4 | 4 | 0.80 | 37.87667 | -0.40684E 00 | 0.74300E-03 |
| 4 | 5 | 0.80 | 37.97172 | 0.57216E 01 | -0.23090E-03 |
| 4 | 6 | 0.80 | 38.08764 | 0.87092E-01 | -0.18413E-02 |
| 4 | 7 | 0.80 | 38.22415 | -0.24146E 01 | -0.92832E-03 |
| 4 | 8 | 0.80 | 38.38106 | 0.91987E 00 | 0.23276E-02 |
| 4 | 9 | 0.80 | 38.55816 | -0.46042E 00 | 0.36373E-02 |
| 4 | 10 | 0.80 | 38.75514 | -0.12741E 03 | 0.38385E-04 |
| 4 | 11 | 0.80 | 38.97167 | 0.53343E 00 | -0.52024E-02 |
| 4 | 12 | 0.80 | 39.20760 | -0.62211E 00 | -0.60112E-02 |
| 4 | 13 | 0.80 | 39.46243 | -0.11580E 03 | -0.71202E-04 |
| 4 | 14 | 0.80 | 39.73586 | 0.70450E 00 | 0.78287E-02 |
| 4 | 15 | 0.80 | 40.02742 | -0.32381E 00 | 0.10587E-01 |
| 4 | 16 | 0.80 | 40.33696 | -0.25886E 01 | 0.45249E-02 |
| 4 | 17 | 0.80 | 40.66391 | 0.19033E 01 | -0.66531E-02 |
| 4 | 18 | 0.80 | 41.00784 | 0.27687E 00 | -0.15447E-01 |
| 4 | 19 | 0.80 | 41.36843 | -0.56257E 00 | -0.15599E-01 |
| 4 | 20 | 0.80 | 41.74520 | -0.31330E 01 | -0.60704E-02 |
| 4 | 21 | 0.80 | 42.13778 | 0.23110E 01 | 0.87910E-02 |
| 4 | 22 | 0.80 | 42.54571 | 0.51547E 00 | 0.21740E-01 |
| 4 | 23 | 0.80 | 42.96856 | -0.18278E 00 | 0.26417E-01 |
| 4 | 24 | 0.80 | 43.40594 | -0.10481E 01 | 0.20272E-01 |
| 4 | 25 | 0.80 | 43.85745 | -0.61469E 01 | 0.51440E-02 |
| 4 | 26 | 0.80 | 44.32261 | 0.22824E 01 | -0.14009E-01 |
| 4 | 27 | 0.80 | 44.80105 | 0.69741E 00 | -0.31099E-01 |
| 4 | 28 | 0.80 | 45.29239 | 0.84655E-01 | -0.40951E-01 |
| 4 | 29 | 0.80 | 45.79620 | -0.44271E 00 | -0.40694E-01 |
| 4 | 30 | 0.80 | 46.31210 | -0.12490E 01 | -0.30044E-01 |
| 4 | 31 | 0.80 | 46.83971 | -0.45237E 01 | -0.11168E-01 |
| 4 | 32 | 0.80 | 47.37866 | 0.44818E 01 | 0.12126E-01 |
| 4 | 33 | 0.80 | 47.92859 | 0.13514E 01 | 0.35594E-01 |
| 4 | 34 | 0.80 | 48.48916 | 0.59263E 00 | 0.55284E-01 |
| 4 | 35 | 0.80 | 49.06002 | 0.15534E 00 | 0.68092E-01 |
| 4 | 36 | 0.80 | 49.64083 | -0.21278E 00 | 0.72120E-01 |
| 4 | 37 | 0.80 | 50.23129 | -0.62286E 00 | 0.66978E-01 |
| 4 | 38 | 0.80 | 50.83108 | -0.12316E 01 | 0.53130E-01 |
| 4 | 39 | 0.80 | 51.43991 | -0.26156E 01 | 0.32121E-01 |
| 4 | 40 | 0.80 | 52.05744 | -0.15944E 02 | 0.60124E-02 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 5 | 1 | 0.80 | 50.27941 | 0.10647E 01 | 0.60044E-04 |
| 5 | 2 | 0.80 | 50.30330 | -0.84288E 00 | 0.66882E-04 |
| 5 | 3 | 0.80 | 50.34305 | 0.14279E 01 | 0.20817E-04 |
| 5 | 4 | 0.80 | 50.39871 | -0.52807E 00 | 0.46737E-04 |
| 5 | 5 | 0.80 | 50.47012 | 0.29642E 01 | -0.28524E-04 |
| 5 | 6 | 0.80 | 50.55734 | -0.13027E 00 | -0.16237E-03 |
| 5 | 7 | 0.80 | 50.66014 | -0.98445E 01 | -0.16921E-04 |
| 5 | 8 | 0.80 | 50.77857 | 0.38419E 00 | 0.22574E-03 |
| 5 | 9 | 0.80 | 50.91247 | -0.12704E 01 | 0.17910E-03 |
| 5 | 10 | 0.80 | 51.06168 | 0.15604E 01 | -0.24398E-03 |
| 5 | 11 | 0.80 | 51.22611 | -0.20495E 00 | -0.50715E-03 |
| 5 | 12 | 0.80 | 51.40557 | -0.49631E 01 | -0.12495E-03 |
| 5 | 13 | 0.80 | 51.60000 | 0.73318E 00 | 0.66886E-03 |
| 5 | 14 | 0.80 | 51.80918 | -0.51046E 00 | 0.90785E-03 |
| 5 | 15 | 0.80 | 52.03292 | -0.38521E 02 | 0.29172E-04 |
| 5 | 16 | 0.80 | 52.27102 | 0.62020E 00 | -0.11001E-02 |
| 5 | 17 | 0.80 | 52.52336 | -0.49012E 00 | -0.14091E-02 |
| 5 | 18 | 0.80 | 52.78974 | -0.73955E 01 | -0.23469E-03 |
| 5 | 19 | 0.80 | 53.06985 | 0.93909E 00 | 0.14615E-02 |
| 5 | 20 | 0.80 | 53.36360 | -0.16981E 00 | 0.22166E-02 |
| 5 | 21 | 0.80 | 53.67062 | -0.17936E 01 | 0.12223E-02 |
| 5 | 22 | 0.80 | 53.99086 | 0.26759E 01 | -0.10103E-02 |
| 5 | 23 | 0.80 | 54.32395 | 0.39238E 00 | -0.30364E-02 |
| 5 | 24 | 0.80 | 54.66983 | -0.46935E 00 | -0.32881E-02 |
| 5 | 25 | 0.80 | 55.02809 | -0.27835E 01 | -0.13801E-02 |
| 5 | 26 | 0.80 | 55.39868 | 0.22575E 01 | 0.18101E-02 |
| 5 | 27 | 0.80 | 55.78116 | 0.44214E 00 | 0.44510E-02 |
| 5 | 28 | 0.80 | 56.17539 | -0.30651E 00 | 0.51468E-02 |
| 5 | 29 | 0.80 | 56.58115 | -0.15169E 01 | 0.33047E-02 |
| 5 | 30 | 0.80 | 56.99817 | 0.11702E 02 | -0.55478E-03 |
| 5 | 31 | 0.80 | 57.42620 | 0.11141E 01 | -0.48220E-02 |
| 5 | 32 | 0.80 | 57.86505 | 0.21774E 00 | -0.77619E-02 |
| 5 | 33 | 0.80 | 58.31445 | -0.41099E 00 | -0.79890E-02 |
| 5 | 34 | 0.80 | 58.77417 | -0.14727E 01 | -0.52457E-02 |
| 5 | 35 | 0.80 | 59.24399 | -0.31705E 02 | -0.32108E-03 |
| 5 | 36 | 0.80 | 59.72368 | 0.17685E 01 | 0.54557E-02 |
| 5 | 37 | 0.80 | 60.21301 | 0.58356E 00 | 0.10383E-01 |
| 5 | 38 | 0.80 | 60.71176 | 0.17968E-01 | 0.13122E-01 |
| 5 | 39 | 0.80 | 61.21970 | -0.51455E 00 | 0.12620E-01 |
| 5 | 40 | 0.80 | 61.73661 | -0.14039E 01 | 0.88569E-02 |

| N | M | HUB | EIGENVALUE | B(N,M) | BETA/GAMMA |
|---|----|------|------------|--------------|--------------|
| 6 | 1 | 0.80 | 62.84304 | 0.10515E 01 | -0.69685E-04 |
| 6 | 2 | 0.80 | 62.86213 | -0.87235E 00 | -0.18670E-03 |
| 6 | 3 | 0.80 | 62.89397 | 0.13271E 01 | 0.17833E-03 |
| 6 | 4 | 0.80 | 62.93846 | -0.60714E 00 | 0.22513E-03 |
| 6 | 5 | 0.80 | 62.99564 | 0.22569E 01 | -0.12117E-03 |
| 6 | 6 | 0.80 | 63.06551 | -0.26612E 00 | -0.41953E-03 |
| 6 | 7 | 0.80 | 63.14797 | 0.13331E 02 | 0.48352E-04 |
| 6 | 8 | 0.80 | 63.24295 | 0.13930E 00 | 0.73194E-03 |
| 6 | 9 | 0.80 | 63.35042 | -0.25064E 01 | 0.33021E-03 |
| 6 | 10 | 0.80 | 63.47041 | 0.75810E 00 | -0.86577E-03 |
| 6 | 11 | 0.80 | 63.60269 | -0.72242E 00 | -0.92155E-03 |
| 6 | 12 | 0.80 | 63.74726 | 0.32122E 01 | 0.41813E-03 |
| 6 | 13 | 0.80 | 63.90411 | 0.49206E-01 | 0.15103E-02 |
| 6 | 14 | 0.80 | 64.07305 | -0.21984E 01 | 0.74644E-03 |
| 6 | 15 | 0.80 | 64.25392 | 0.10958E 01 | -0.14099E-02 |
| 6 | 16 | 0.80 | 64.44683 | -0.31942E 00 | -0.22350E-02 |
| 6 | 17 | 0.80 | 64.65155 | -0.67415E 01 | -0.37418E-03 |
| 6 | 18 | 0.80 | 64.86799 | 0.72807E 00 | 0.23408E-02 |
| 6 | 19 | 0.80 | 65.09600 | -0.46365E 00 | 0.28643E-02 |
| 6 | 20 | 0.80 | 65.33551 | -0.10161E 02 | 0.34491E-03 |
| 6 | 21 | 0.80 | 65.58630 | 0.76788E 00 | -0.29798E-02 |
| 6 | 22 | 0.80 | 65.84844 | -0.34797E 00 | -0.38303E-02 |
| 6 | 23 | 0.80 | 66.12159 | -0.36142E 01 | -0.12252E-02 |
| 6 | 24 | 0.80 | 66.40573 | 0.12554E 01 | 0.30793E-02 |
| 6 | 25 | 0.80 | 66.70071 | -0.21291E-01 | 0.52854E-02 |
| 6 | 26 | 0.80 | 67.00643 | -0.13079E 01 | 0.35229E-02 |
| 6 | 27 | 0.80 | 67.32258 | 0.44324E 01 | -0.13777E-02 |
| 6 | 28 | 0.80 | 67.64924 | 0.54138E 00 | -0.58441E-02 |
| 6 | 29 | 0.80 | 67.98609 | -0.34827E 00 | -0.67325E-02 |
| 6 | 30 | 0.80 | 68.33308 | -0.22074E 01 | -0.31733E-02 |
| 6 | 31 | 0.80 | 68.69004 | 0.26221E 01 | 0.29583E-02 |
| 6 | 32 | 0.80 | 69.05679 | 0.46700E 00 | 0.79249E-02 |
| 6 | 33 | 0.80 | 69.43318 | -0.32349E 00 | 0.89343E-02 |
| 6 | 34 | 0.80 | 69.81913 | -0.17164E 01 | 0.50402E-02 |
| 6 | 35 | 0.80 | 70.21434 | 0.53722E 01 | -0.19390E-02 |
| 6 | 36 | 0.80 | 70.61883 | 0.83173E 00 | -0.86892E-02 |
| 6 | 37 | 0.80 | 71.03239 | 0.18944E-01 | -0.11916E-01 |
| 6 | 38 | 0.80 | 71.45478 | -0.74189E 00 | -0.10133E-01 |
| 6 | 39 | 0.80 | 71.88591 | -0.33198E 01 | -0.38562E-02 |
| 6 | 40 | 0.80 | 72.32574 | 0.29157E 01 | 0.45306E-02 |

APPENDIX B
Three-Dimensional Velocity
Components for $\eta_H = 0.70$

APPENDIX B

Key to Computer Output:

Radial Coordinate = η

Axial Coordinate = ξ

Theta = θ

CR = C_{η}

CX = C_{ξ}

CT = C_{θ}

Limits of Integration Used:

| | | |
|---|---------------|----------------|
| $\xi = 0.05 - 0.15 ; \theta = 0^{\circ} - 180^{\circ}$ | $\frac{N}{6}$ | $\frac{M}{40}$ |
| $\xi = 0.20 - 1.00 ; \theta = 0^{\circ} - 15^{\circ}$ | 4 | 40 |
| $\xi = 0.20 - 1.00 ; \theta = 15^{\circ} - 180^{\circ}$ | 2 | 26 |

Note: In most cases two values for $\theta = 15^{\circ}$ are listed.
The first is for $N = 4, M = 40$ and the second for $N = 2, M = 26$.

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RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.7999

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.182100
THETA= 5.0, CR= 0.000000 CX= -0.017357 CT= 0.180601
THETA= 10.0, CR= 0.000000 CX= -0.033372 CT= 0.178267
THETA= 15.0, CR= 0.000002 CX= -0.048313 CT= 0.169541
THETA= 20.0, CR= 0.000002 CX= -0.060571 CT= 0.161039
THETA= 25.0, CR= 0.000003 CX= -0.070279 CT= 0.151419
THETA= 30.0, CR= 0.000003 CX= -0.077471 CT= 0.141283
THETA= 45.0, CR= 0.000004 CX= -0.086469 CT= 0.111957
THETA= 90.0, CR= 0.000002 CX= -0.063502 CT= 0.048538
THETA= 135.0, CR= 0.000000 CX= -0.030375 CT= 0.043687
THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.0435021

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.2000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.725004
THETA= 5.0, CR= 0.000006 CX= -0.284533 CT= 0.619491
THETA= 10.0, CR= 0.000010 CX= -0.496740 CT= 0.434389
THETA= 15.0, CR= 0.000012 CX= -0.398404 CT= 0.293852
THETA= 20.0, CR= 0.000012 CX= -0.396459 CT= 0.293933
THETA= 25.0, CR= 0.000012 CX= -0.365454 CT= 0.205814
THETA= 30.0, CR= 0.000013 CX= -0.324398 CT= 0.147679
THETA= 45.0, CR= 0.000013 CX= -0.287288 CT= 0.113377
THETA= 90.0, CR= 0.000003 CX= -0.205958 CT= 0.058513
THETA= 135.0, CR= -0.000001 CX= -0.037871 CT= 0.018100
THETA= 180.0, CR= -0.000000 CX= 0.000000 CT= 0.009654

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.0500

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 2.686609
THETA= 5.0, CR= 0.000017 CX= -1.630186 CT= 0.807277
THETA= 10.0, CR= 0.000022 CX= -0.809352 CT= 0.300014
THETA= 15.0, CR= 0.000025 CX= -0.690362 CT= 0.054692
THETA= 20.0, CR= 0.000016 CX= -0.491375 CT= 0.125959
THETA= 25.0, CR= 0.000017 CX= -0.392170 CT= 0.001589
THETA= 30.0, CR= 0.000015 CX= -0.364675 CT= 0.062514
THETA= 45.0, CR= 0.000023 CX= -0.197402 CT= 0.024060
THETA= 90.0, CR= 0.000003 CX= -0.082377 CT= 0.014452
THETA= 135.0, CR= -0.000002 CX= -0.034428 CT= 0.012732
THETA= 180.0, CR= -0.000000 CX= -0.000004 CT= 0.012397

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.9999

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.150688
THETA= 5.0, CR= 0.000000 CX= -0.010601 CT= 0.149936
THETA= 10.0, CR= 0.000000 CX= -0.020605 CT= 0.147733
THETA= 15.0, CR= 0.000001 CX= -0.030259 CT= 0.144223
THETA= 20.0, CR= 0.000001 CX= -0.030259 CT= 0.144223
THETA= 25.0, CR= 0.000002 CX= -0.038680 CT= 0.139624
THETA= 30.0, CR= 0.000002 CX= -0.045909 CT= 0.128188
THETA= 45.0, CR= 0.000003 CX= -0.062211 CT= 0.109042
THETA= 90.0, CR= 0.000002 CX= -0.052780 CT= 0.065757
THETA= 135.0, CR= 0.000000 CX= -0.026698 CT= 0.047135
THETA= 180.0, CR= -0.000000 CX= 0.000000 CT= 0.042192

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.4000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.353161
THETA= 5.0, CR= 0.000004 CX= -0.074839 CT= 0.340124
THETA= 10.0, CR= 0.000004 CX= -0.134059 CT= 0.306611
THETA= 15.0, CR= 0.000006 CX= -0.171474 CT= 0.264187
THETA= 20.0, CR= 0.000006 CX= -0.171469 CT= 0.265187
THETA= 25.0, CR= 0.000007 CX= -0.189735 CT= 0.222274
THETA= 30.0, CR= 0.000008 CX= -0.194652 CT= 0.185462
THETA= 45.0, CR= 0.000008 CX= -0.191475 CT= 0.156937
THETA= 90.0, CR= 0.000009 CX= -0.163498 CT= 0.094570
THETA= 135.0, CR= 0.000003 CX= -0.084404 CT= 0.034880
THETA= 180.0, CR= -0.000000 CX= 0.000000 CT= 0.021402

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.1500

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 1.479260
THETA= 5.0, CR= 0.000011 CX= -0.819745 CT= 0.881982
THETA= 10.0, CR= 0.000016 CX= -0.714528 CT= 0.397583
THETA= 15.0, CR= 0.000016 CX= -0.583253 CT= 0.204065
THETA= 20.0, CR= 0.000016 CX= -0.463762 CT= 0.136062
THETA= 25.0, CR= 0.000015 CX= -0.365433 CT= 0.082235
THETA= 30.0, CR= 0.000015 CX= -0.330550 CT= 0.067307
THETA= 45.0, CR= 0.000018 CX= -0.216519 CT= 0.031451
THETA= 90.0, CR= 0.000003 CX= -0.091805 CT= 0.010474
THETA= 135.0, CR= -0.000002 CX= -0.038178 CT= 0.006706
THETA= 180.0, CR= -0.000000 CX= -0.000000 CT= 0.005931

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.6000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.237116
THETA= 5.0, CR= 0.000001 CX= -0.032167 CT= 0.233448
THETA= 10.0, CR= 0.000002 CX= -0.061186 CT= 0.223161
THETA= 15.0, CR= 0.000003 CX= -0.084561 CT= 0.208066
THETA= 20.0, CR= 0.000003 CX= -0.084861 CT= 0.208066
THETA= 25.0, CR= 0.000004 CX= -0.102339 CT= 0.190337
THETA= 30.0, CR= 0.000005 CX= -0.113089 CT= 0.171868
THETA= 45.0, CR= 0.000005 CX= -0.120411 CT= 0.153988
THETA= 90.0, CR= 0.000003 CX= -0.120371 CT= 0.109580
THETA= 135.0, CR= 0.000003 CX= -0.074462 CT= 0.048367
THETA= 180.0, CR= -0.000000 CX= -0.033745 CT= 0.031073

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.0000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.000000
THETA= 5.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 10.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 15.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 20.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 25.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 30.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 45.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 90.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 135.0, CR= 0.000000 CX= -0.000000 CT= 0.000000
THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.000000

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.1500

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.980163
THETA= 5.0, CR= 0.000008 CX= -0.560804 CT= 0.749424
THETA= 10.0, CR= 0.000013 CX= -0.540513 CT= 0.442433
THETA= 15.0, CR= 0.000014 CX= -0.487405 CT= 0.267111
THETA= 20.0, CR= 0.000014 CX= -0.417433 CT= 0.175757
THETA= 25.0, CR= 0.000014 CX= -0.358067 CT= 0.121865
THETA= 30.0, CR= 0.000014 CX= -0.310307 CT= 0.090886
THETA= 45.0, CR= 0.000015 CX= -0.213349 CT= 0.044865
THETA= 90.0, CR= 0.000003 CX= -0.092199 CT= 0.014019
THETA= 135.0, CR= -0.000001 CX= -0.038480 CT= 0.008360
THETA= 180.0, CR= 0.000000 CX= -0.000000 CT= 0.007181

THREE DIMENSIONAL VELOCITY COMPONENTS FOR η = 1.00, η_H = 0.700

HYDRONAUTICS, INCORPORATED

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.7999

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.798977
 THETA= 5.0, CR= 0.032706 CX= -0.258100 CT= 0.701901
 THETA= 10.0, CR= 0.041189 CX= -0.377800 CT= 0.515282
 THETA= 15.0, CR= 0.034669 CX= -0.391315 CT= 0.358187
 THETA= 20.0, CR= 0.034354 CX= -0.390069 CT= 0.2356075
 THETA= 25.0, CR= 0.025618 CX= -0.368216 CT= 0.162290
 THETA= 30.0, CR= 0.017902 CX= -0.326115 CT= 0.138285
 THETA= 35.0, CR= 0.012489 CX= -0.289679 CT= 0.070154
 THETA= 40.0, CR= 0.004627 CX= -0.207372 CT= 0.021577
 THETA= 45.0, CR= 0.000720 CX= -0.091770 CT= 0.014270
 THETA= 135.0, CR= 0.000118 CX= -0.038164 CT= 0.011222
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.011222

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.2000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.798977
 THETA= 5.0, CR= 0.032706 CX= -0.258100 CT= 0.701901
 THETA= 10.0, CR= 0.041189 CX= -0.377800 CT= 0.515282
 THETA= 15.0, CR= 0.034669 CX= -0.391315 CT= 0.358187
 THETA= 20.0, CR= 0.034354 CX= -0.390069 CT= 0.2356075
 THETA= 25.0, CR= 0.025618 CX= -0.368216 CT= 0.162290
 THETA= 30.0, CR= 0.017902 CX= -0.326115 CT= 0.138285
 THETA= 35.0, CR= 0.012489 CX= -0.289679 CT= 0.070154
 THETA= 40.0, CR= 0.004627 CX= -0.207372 CT= 0.021577
 THETA= 45.0, CR= 0.000720 CX= -0.091770 CT= 0.014270
 THETA= 135.0, CR= 0.000118 CX= -0.038164 CT= 0.011222
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.011222

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.1000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 2.889848
 THETA= 5.0, CR= 0.084740 CX= -1.635649 CT= 1.0726419
 THETA= 10.0, CR= 0.033680 CX= -0.878498 CT= 0.3671619
 THETA= 15.0, CR= 0.022508 CX= -0.716501 CT= 0.100970
 THETA= 20.0, CR= 0.011003 CX= -0.510628 CT= 0.137592
 THETA= 25.0, CR= 0.006264 CX= -0.406681 CT= 0.193660
 THETA= 30.0, CR= 0.005562 CX= -0.367738 CT= 0.066761
 THETA= 35.0, CR= 0.000150 CX= -0.206415 CT= 0.025974
 THETA= 40.0, CR= 0.000378 CX= -0.085090 CT= 0.013930
 THETA= 45.0, CR= 0.000178 CX= -0.038271 CT= 0.011856
 THETA= 135.0, CR= 0.000000 CX= -0.000000 CT= 0.011427
 THETA= 180.0, CR= 0.000000 CX= -0.000000 CT= 0.011427

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.4000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.404416
 THETA= 5.0, CR= 0.008067 CX= -0.070008 CT= 0.391077
 THETA= 10.0, CR= 0.013955 CX= -0.126952 CT= 0.356032
 THETA= 15.0, CR= 0.015722 CX= -0.164764 CT= 0.310141
 THETA= 20.0, CR= 0.015721 CX= -0.164764 CT= 0.310139
 THETA= 25.0, CR= 0.015333 CX= -0.184691 CT= 0.263214
 THETA= 30.0, CR= 0.013607 CX= -0.191372 CT= 0.220839
 THETA= 35.0, CR= 0.011465 CX= -0.189569 CT= 0.184906
 THETA= 40.0, CR= 0.006165 CX= -0.163423 CT= 0.112873
 THETA= 45.0, CR= 0.001173 CX= -0.084479 CT= 0.041265
 THETA= 135.0, CR= 0.000408 CX= -0.036543 CT= 0.025239
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.021744

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.6000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.600000
 THETA= 5.0, CR= 0.002741 CX= -0.030941 CT= 0.271380
 THETA= 10.0, CR= 0.005030 CX= -0.059071 CT= 0.2660097
 THETA= 15.0, CR= 0.004588 CX= -0.082350 CT= 0.2453355
 THETA= 20.0, CR= 0.006588 CX= -0.082350 CT= 0.2453355
 THETA= 25.0, CR= 0.007368 CX= -0.099671 CT= 0.2223427
 THETA= 30.0, CR= 0.007498 CX= -0.111739 CT= 0.202389
 THETA= 35.0, CR= 0.007179 CX= -0.118691 CT= 0.181781
 THETA= 40.0, CR= 0.005204 CX= -0.119739 CT= 0.129786
 THETA= 45.0, CR= 0.001431 CX= -0.074527 CT= 0.057148
 THETA= 135.0, CR= 0.000415 CX= -0.0333784 CT= 0.036634
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.031892

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.9999

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.176503
 THETA= 5.0, CR= 0.000614 CX= -0.010423 CT= 0.175644
 THETA= 10.0, CR= 0.001188 CX= -0.020480 CT= 0.173125
 THETA= 15.0, CR= 0.001689 CX= -0.029812 CT= 0.169105
 THETA= 20.0, CR= 0.001689 CX= -0.029812 CT= 0.169105
 THETA= 25.0, CR= 0.002095 CX= -0.038160 CT= 0.163824
 THETA= 30.0, CR= 0.002394 CX= -0.045343 CT= 0.157567
 THETA= 35.0, CR= 0.002588 CX= -0.051274 CT= 0.150632
 THETA= 40.0, CR= 0.002658 CX= -0.061766 CT= 0.128377
 THETA= 45.0, CR= 0.001371 CX= -0.052715 CT= 0.075528
 THETA= 135.0, CR= 0.000497 CX= -0.026699 CT= 0.055538
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.049699

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.4000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.404416
 THETA= 5.0, CR= 0.008067 CX= -0.070008 CT= 0.391077
 THETA= 10.0, CR= 0.013955 CX= -0.126952 CT= 0.356032
 THETA= 15.0, CR= 0.015722 CX= -0.164764 CT= 0.310141
 THETA= 20.0, CR= 0.015721 CX= -0.164764 CT= 0.310139
 THETA= 25.0, CR= 0.015333 CX= -0.184691 CT= 0.263214
 THETA= 30.0, CR= 0.013607 CX= -0.191372 CT= 0.220839
 THETA= 35.0, CR= 0.011465 CX= -0.189569 CT= 0.184906
 THETA= 40.0, CR= 0.006165 CX= -0.163423 CT= 0.112873
 THETA= 45.0, CR= 0.001173 CX= -0.084479 CT= 0.041265
 THETA= 135.0, CR= 0.000408 CX= -0.036543 CT= 0.025239
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.021744

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.1500

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 1.579560
 THETA= 5.0, CR= 0.069812 CX= -0.769299 CT= 1.032239
 THETA= 10.0, CR= 0.051015 CX= -0.727781 CT= 0.499328
 THETA= 15.0, CR= 0.033633 CX= -0.598280 CT= 0.265148
 THETA= 20.0, CR= 0.019941 CX= -0.476539 CT= 0.1688603
 THETA= 25.0, CR= 0.012484 CX= -0.394488 CT= 0.106506
 THETA= 30.0, CR= 0.008313 CX= -0.335504 CT= 0.081263
 THETA= 35.0, CR= 0.002501 CX= -0.220011 CT= 0.037365
 THETA= 40.0, CR= 0.000248 CX= -0.092643 CT= 0.011782
 THETA= 45.0, CR= 0.000038 CX= -0.036485 CT= 0.007270
 THETA= 135.0, CR= 0.000000 CX= -0.000000 CT= 0.006337
 THETA= 180.0, CR= 0.000000 CX= -0.000000 CT= 0.006337

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.1500

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 1.062677
 THETA= 5.0, CR= 0.048403 CX= -0.420638 CT= 0.854220
 THETA= 10.0, CR= 0.030607 CX= -0.526792 CT= 0.537436
 THETA= 15.0, CR= 0.036991 CX= -0.488290 CT= 0.333279
 THETA= 20.0, CR= 0.024568 CX= -0.422385 CT= 0.219098
 THETA= 25.0, CR= 0.016241 CX= -0.363080 CT= 0.151907
 THETA= 30.0, CR= 0.010934 CX= -0.314271 CT= 0.111654
 THETA= 35.0, CR= 0.003852 CX= -0.215464 CT= 0.054164
 THETA= 40.0, CR= 0.000499 CX= -0.092591 CT= 0.016513
 THETA= 45.0, CR= 0.000115 CX= -0.038600 CT= 0.003765
 THETA= 135.0, CR= 0.000000 CX= -0.000000 CT= 0.003861
 THETA= 180.0, CR= 0.000000 CX= -0.000000 CT= 0.003861

THREE DIMENSIONAL VELOCITY COMPONENTS FOR $\eta = 0.850, \eta_H = 0.700$

HYDRONAUTICS, INCORPORATED

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.2000
 THETA= 0.0, CK= 0.000000 CX= 0.000000 CT= 0.835097
 THETA= 5.0, CK= 0.000984 CX= -0.016628 CT= 0.231997
 THETA= 10.0, CK= 0.001891 CX= -0.032391 CT= 0.230214
 THETA= 15.0, CK= 0.002623 CX= -0.046558 CT= 0.2225036
 THETA= 20.0, CK= 0.003145 CX= -0.058620 CT= 0.216941
 THETA= 25.0, CK= 0.003456 CX= -0.068328 CT= 0.206609
 THETA= 30.0, CK= 0.003579 CX= -0.075660 CT= 0.194207
 THETA= 35.0, CK= 0.003217 CX= -0.085385 CT= 0.141217
 THETA= 40.0, CK= 0.001252 CX= -0.063467 CT= 0.075956
 THETA= 45.0, CK= 0.000405 CX= -0.030409 CT= 0.051377
 THETA= 135.0, CK= -0.000000 CX= 0.000000 CT= 0.045300
 THETA= 180.0, CK= -0.000000 CX= 0.000000 CT= 0.045300

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.4000
 THETA= 0.0, CK= 0.000000 CX= 0.000000 CT= 0.835097
 THETA= 5.0, CK= 0.027090 CX= -0.239559 CT= 0.746963
 THETA= 10.0, CK= 0.035136 CX= -0.362257 CT= 0.566372
 THETA= 15.0, CK= 0.030159 CX= -0.384610 CT= 0.402329
 THETA= 20.0, CK= 0.029953 CX= -0.384270 CT= 0.2402383
 THETA= 25.0, CK= 0.022415 CX= -0.362784 CT= 0.286106
 THETA= 30.0, CK= 0.015724 CX= -0.327184 CT= 0.207362
 THETA= 35.0, CK= 0.010949 CX= -0.291472 CT= 0.156163
 THETA= 40.0, CK= 0.004178 CX= -0.208506 CT= 0.078203
 THETA= 45.0, CK= 0.000608 CX= -0.091895 CT= 0.023883
 THETA= 135.0, CK= 0.000107 CX= -0.036313 CT= 0.014107
 THETA= 180.0, CK= 0.000000 CX= 0.000000 CT= 0.012216

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.6000
 THETA= 0.0, CK= 0.000000 CX= 0.000000 CT= 0.835097
 THETA= 5.0, CK= 0.034824 CX= -0.636172 CT= 1.169970
 THETA= 10.0, CK= 0.032656 CX= -0.931546 CT= 0.620964
 THETA= 15.0, CK= 0.021473 CX= -0.730763 CT= 0.137849
 THETA= 20.0, CK= 0.010166 CX= -0.526752 CT= 0.146799
 THETA= 25.0, CK= 0.005738 CX= -0.418102 CT= 0.035931
 THETA= 30.0, CK= 0.004935 CX= -0.370930 CT= 0.069642
 THETA= 35.0, CK= 0.000102 CX= -0.209380 CT= 0.027245
 THETA= 40.0, CK= -0.000291 CX= -0.086454 CT= 0.013395
 THETA= 45.0, CK= -0.000156 CX= -0.035807 CT= 0.011073
 THETA= 135.0, CK= 0.000000 CX= -0.000003 CT= 0.010583
 THETA= 180.0, CK= 0.000000 CX= -0.000000 CT= 0.010583

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.8000
 THETA= 0.0, CK= 0.000000 CX= 0.000000 CT= 0.835097
 THETA= 5.0, CK= 0.063445 CX= -0.732622 CT= 1.614691
 THETA= 10.0, CK= 0.049584 CX= -0.733715 CT= 1.117796
 THETA= 15.0, CK= 0.031020 CX= -0.606414 CT= 0.572688
 THETA= 20.0, CK= 0.018204 CX= -0.446562 CT= 0.311365
 THETA= 25.0, CK= 0.011251 CX= -0.401701 CT= 0.194245
 THETA= 30.0, CK= 0.007364 CX= -0.401701 CT= 0.124622
 THETA= 35.0, CK= 0.002209 CX= -0.222454 CT= 0.091874
 THETA= 40.0, CK= 0.000230 CX= -0.093137 CT= 0.041921
 THETA= 45.0, CK= 0.000041 CX= -0.038652 CT= 0.012682
 THETA= 135.0, CK= 0.000000 CX= -0.000000 CT= 0.007675
 THETA= 180.0, CK= 0.000000 CX= -0.000000 CT= 0.006633

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.9999
 THETA= 0.0, CK= 0.000000 CX= 0.000000 CT= 0.835097
 THETA= 5.0, CK= 0.000984 CX= -0.016628 CT= 0.231997
 THETA= 10.0, CK= 0.001891 CX= -0.032391 CT= 0.230214
 THETA= 15.0, CK= 0.002623 CX= -0.046558 CT= 0.2225036
 THETA= 20.0, CK= 0.003145 CX= -0.058620 CT= 0.216941
 THETA= 25.0, CK= 0.003456 CX= -0.068328 CT= 0.206609
 THETA= 30.0, CK= 0.003579 CX= -0.075660 CT= 0.194207
 THETA= 35.0, CK= 0.003217 CX= -0.085385 CT= 0.141217
 THETA= 40.0, CK= 0.001252 CX= -0.063467 CT= 0.075956
 THETA= 45.0, CK= 0.000405 CX= -0.030409 CT= 0.051377
 THETA= 135.0, CK= -0.000000 CX= 0.000000 CT= 0.045300
 THETA= 180.0, CK= -0.000000 CX= 0.000000 CT= 0.045300

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.4000
 THETA= 0.0, CK= 0.000000 CX= 0.000000 CT= 0.835097
 THETA= 5.0, CK= 0.006593 CX= -0.066501 CT= 0.434553
 THETA= 10.0, CK= 0.011146 CX= -0.121654 CT= 0.421419
 THETA= 15.0, CK= 0.013082 CX= -0.159593 CT= 0.386370
 THETA= 20.0, CK= 0.013083 CX= -0.159593 CT= 0.339323
 THETA= 25.0, CK= 0.012895 CX= -0.180683 CT= 0.339323
 THETA= 30.0, CK= 0.011534 CX= -0.180683 CT= 0.249944
 THETA= 35.0, CK= 0.009720 CX= -0.187980 CT= 0.244369
 THETA= 40.0, CK= 0.005281 CX= -0.163339 CT= 0.205197
 THETA= 45.0, CK= 0.005281 CX= -0.163339 CT= 0.125210
 THETA= 135.0, CK= 0.001000 CX= -0.084618 CT= 0.045457
 THETA= 180.0, CK= 0.000000 CX= 0.000000 CT= 0.023878

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.6000
 THETA= 0.0, CK= 0.000000 CX= 0.000000 CT= 0.835097
 THETA= 5.0, CK= 0.002261 CX= -0.030022 CT= 0.294897
 THETA= 10.0, CK= 0.004164 CX= -0.057472 CT= 0.283180
 THETA= 15.0, CK= 0.005479 CX= -0.080429 CT= 0.265652
 THETA= 20.0, CK= 0.005479 CX= -0.080429 CT= 0.265652
 THETA= 25.0, CK= 0.006158 CX= -0.097359 CT= 0.244576
 THETA= 30.0, CK= 0.006298 CX= -0.110054 CT= 0.222099
 THETA= 35.0, CK= 0.006054 CX= -0.117128 CT= 0.169871
 THETA= 40.0, CK= 0.004422 CX= -0.119226 CT= 0.143091
 THETA= 45.0, CK= 0.001219 CX= -0.074577 CT= 0.062892
 THETA= 135.0, CK= 0.000353 CX= -0.033815 CT= 0.040246
 THETA= 180.0, CK= -0.000000 CX= 0.000000 CT= 0.035020

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.8000
 THETA= 0.0, CK= 0.000000 CX= 0.000000 CT= 0.835097
 THETA= 5.0, CK= 0.041365 CX= -0.392300 CT= 0.910990
 THETA= 10.0, CK= 0.044754 CX= -0.513361 CT= 0.604048
 THETA= 15.0, CK= 0.033068 CX= -0.467498 CT= 0.381082
 THETA= 20.0, CK= 0.021973 CX= -0.425829 CT= 0.251447
 THETA= 25.0, CK= 0.014442 CX= -0.366896 CT= 0.174140
 THETA= 30.0, CK= 0.009650 CX= -0.317466 CT= 0.126380
 THETA= 35.0, CK= 0.003557 CX= -0.217080 CT= 0.060682
 THETA= 40.0, CK= 0.000432 CX= -0.092860 CT= 0.018169
 THETA= 45.0, CK= 0.000102 CX= -0.038675 CT= 0.010695
 THETA= 135.0, CK= 0.000000 CX= -0.000000 CT= 0.009139
 THETA= 180.0, CK= 0.000000 CX= -0.000000 CT= 0.009139

THREE DIMENSIONAL VELOCITY COMPONENTS FOR $\eta = 0.775, \eta_H = 0.700$

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.7999

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.256135
 THETA= 5.0, CR= -0.000000 CX= -0.016470 CT= 0.254195
 THETA= 10.0, CR= -0.000000 CX= -0.032101 CT= 0.248560
 THETA= 15.0, CR= -0.000000 CX= -0.046176 CT= 0.239736
 THETA= 20.0, CR= -0.000000 CX= -0.046176 CT= 0.228449
 THETA= 25.0, CR= -0.000000 CX= -0.058193 CT= 0.215911
 THETA= 30.0, CR= -0.000000 CX= -0.067898 CT= 0.201698
 THETA= 35.0, CR= -0.000000 CX= -0.075258 CT= 0.160838
 THETA= 40.0, CR= -0.000000 CX= -0.085140 CT= 0.084200
 THETA= 45.0, CR= -0.000000 CX= -0.063458 CT= 0.056923
 THETA= 135.0, CR= 0.000000 CX= -0.030416 CT= 0.056181
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.050181

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.2000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.901263
 THETA= 5.0, CR= -0.000000 CX= -0.229245 CT= 0.813619
 THETA= 10.0, CR= -0.000000 CX= -0.353281 CT= 0.627463
 THETA= 15.0, CR= -0.000000 CX= -0.380744 CT= 0.451128
 THETA= 20.0, CR= -0.000000 CX= -0.380531 CT= 0.451158
 THETA= 25.0, CR= -0.000000 CX= -0.361620 CT= 0.232096
 THETA= 30.0, CR= -0.000000 CX= -0.327573 CT= 0.175567
 THETA= 35.0, CR= -0.000000 CX= -0.292333 CT= 0.087333
 THETA= 40.0, CR= -0.000000 CX= -0.209089 CT= 0.026558
 THETA= 45.0, CR= -0.000000 CX= -0.091963 CT= 0.015659
 THETA= 135.0, CR= 0.000000 CX= -0.036384 CT= 0.013482
 THETA= 180.0, CR= -0.000000 CX= 0.000000 CT= 0.013482

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.0500

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 3.129155
 THETA= 5.0, CR= -0.000000 CX= -1.617191 CT= 1.334933
 THETA= 10.0, CR= -0.000000 CX= -0.965258 CT= 0.479684
 THETA= 15.0, CR= -0.000000 CX= -0.743830 CT= 0.173032
 THETA= 20.0, CR= -0.000000 CX= -0.535840 CT= 0.157905
 THETA= 25.0, CR= -0.000000 CX= -0.426942 CT= 0.064388
 THETA= 30.0, CR= -0.000000 CX= -0.316694 CT= 0.023708
 THETA= 35.0, CR= -0.000000 CX= -0.211698 CT= 0.023114
 THETA= 40.0, CR= -0.000000 CX= -0.087849 CT= 0.013273
 THETA= 45.0, CR= -0.000000 CX= -0.036261 CT= 0.010564
 THETA= 135.0, CR= -0.000000 CX= -0.000000 CT= 0.010107
 THETA= 180.0, CR= -0.000000 CX= 0.000000 CT= 0.010107

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.4000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.476192
 THETA= 5.0, CR= -0.000000 CX= -0.064763 CT= 0.462433
 THETA= 10.0, CR= -0.000000 CX= -0.118994 CT= 0.425433
 THETA= 15.0, CR= -0.000000 CX= -0.156956 CT= 0.375144
 THETA= 20.0, CR= -0.000000 CX= -0.178607 CT= 0.321656
 THETA= 25.0, CR= -0.000000 CX= -0.171730 CT= 0.271730
 THETA= 30.0, CR= -0.000000 CX= -0.228463 CT= 0.228463
 THETA= 35.0, CR= -0.000000 CX= -0.139428 CT= 0.139428
 THETA= 40.0, CR= -0.000000 CX= -0.084689 CT= 0.050440
 THETA= 45.0, CR= -0.000000 CX= -0.036613 CT= 0.030735
 THETA= 135.0, CR= -0.000000 CX= 0.000000 CT= 0.026453
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.026453

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.1000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 1.711423
 THETA= 5.0, CR= -0.000000 CX= -0.703960 CT= 1.228441
 THETA= 10.0, CR= -0.000000 CX= -0.734054 CT= 0.651272
 THETA= 15.0, CR= -0.000000 CX= -0.611047 CT= 0.358060
 THETA= 20.0, CR= -0.000000 CX= -0.491799 CT= 0.220970
 THETA= 25.0, CR= -0.000000 CX= -0.405492 CT= 0.142764
 THETA= 30.0, CR= -0.000000 CX= -0.342132 CT= 0.103357
 THETA= 35.0, CR= -0.000000 CX= -0.223796 CT= 0.046882
 THETA= 40.0, CR= -0.000000 CX= -0.093423 CT= 0.013891
 THETA= 45.0, CR= -0.000000 CX= -0.030747 CT= 0.008312
 THETA= 135.0, CR= -0.000000 CX= -0.000000 CT= 0.007150
 THETA= 180.0, CR= -0.000000 CX= 0.000000 CT= 0.007150

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.6000

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.329415
 THETA= 5.0, CR= -0.000000 CX= -0.059568 CT= 0.324976
 THETA= 10.0, CR= -0.000000 CX= -0.056679 CT= 0.312359
 THETA= 15.0, CR= -0.000000 CX= -0.079470 CT= 0.293405
 THETA= 20.0, CR= -0.000000 CX= -0.096998 CT= 0.270500
 THETA= 25.0, CR= -0.000000 CX= -0.109200 CT= 0.245943
 THETA= 30.0, CR= -0.000000 CX= -0.116632 CT= 0.221553
 THETA= 35.0, CR= -0.000000 CX= -0.118961 CT= 0.158839
 THETA= 40.0, CR= -0.000000 CX= -0.074602 CT= 0.069751
 THETA= 45.0, CR= -0.000000 CX= -0.033831 CT= 0.064596
 THETA= 135.0, CR= 0.000000 CX= -0.000000 CT= 0.038796
 THETA= 180.0, CR= 0.000000 CX= 0.000000 CT= 0.038796

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.1500

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 1.175876
 THETA= 5.0, CR= -0.000000 CX= -0.374713 CT= 0.992736
 THETA= 10.0, CR= -0.000000 CX= -0.504963 CT= 0.671301
 THETA= 15.0, CR= -0.000000 CX= -0.486143 CT= 0.431400
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 THETA= 25.0, CR= -0.000000 CX= -0.368775 CT= 0.197303
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 THETA= 40.0, CR= -0.000000 CX= -0.092998 CT= 0.020153
 THETA= 45.0, CR= -0.000000 CX= -0.036712 CT= 0.011836
 THETA= 135.0, CR= -0.000000 CX= -0.000000 CT= 0.010105
 THETA= 180.0, CR= -0.000000 CX= 0.000000 CT= 0.010105

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.9999

THETA= 0.0, CR= 0.000000 CX= 0.000000 CT= 0.213218
 THETA= 5.0, CR= -0.000000 CX= -0.010293 CT= 0.212311
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 THETA= 35.0, CR= -0.000000 CX= -0.050604 CT= 0.182648
 THETA= 40.0, CR= -0.000000 CX= -0.061237 CT= 0.156014
 THETA= 45.0, CR= -0.000000 CX= -0.052632 CT= 0.094382
 THETA= 135.0, CR= 0.000000 CX= -0.026700 CT= 0.067562
 THETA= 180.0, CR= -0.000000 CX= 0.000000 CT= 0.060437

THREE DIMENSIONAL VELOCITY COMPONENTS FOR $\eta = 0.7000, \eta_H = 0.7000$

HYDRONAUTICS, INCORPORATED

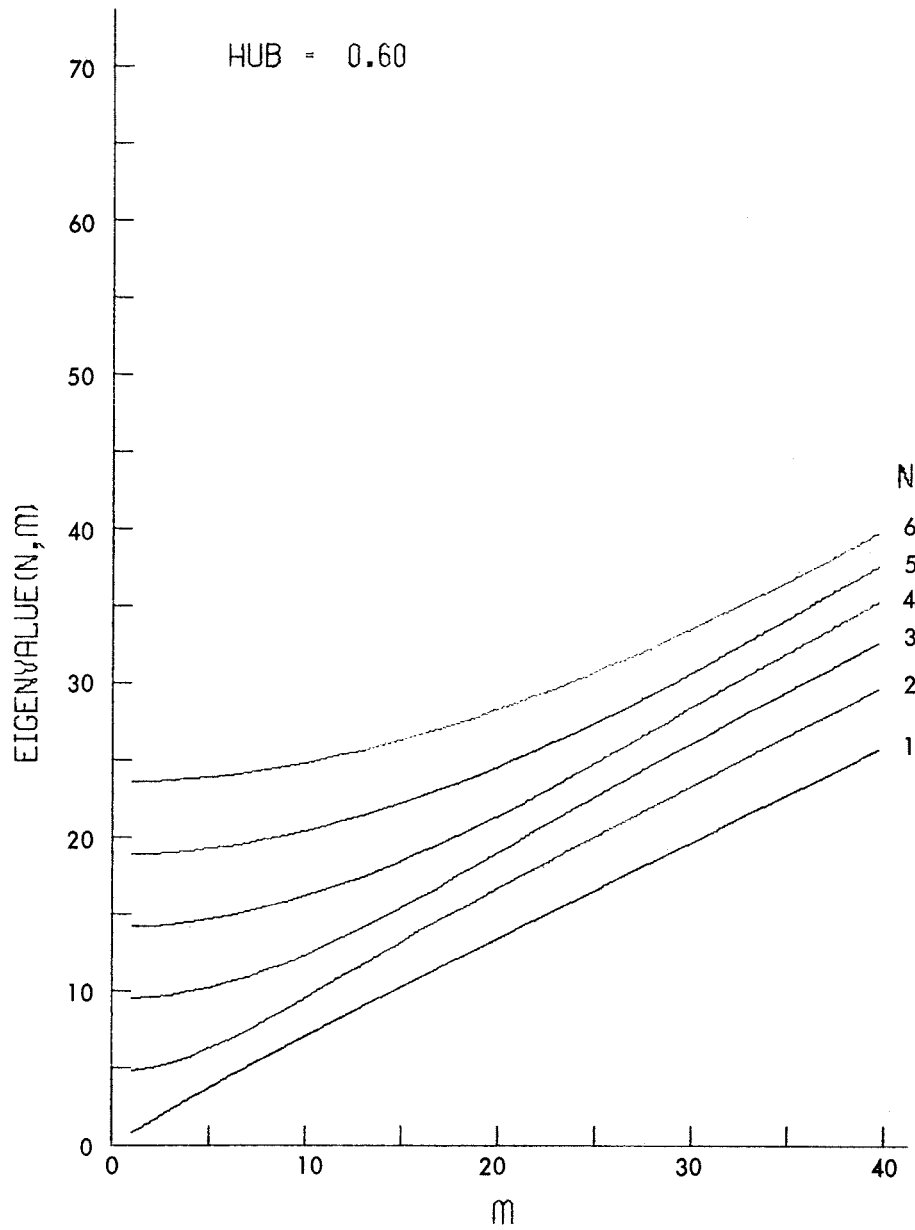


FIGURE 1 - EIGENVALUES FOR A 0.60 HUB RATIO

HYDRONAUTICS, INCORPORATED

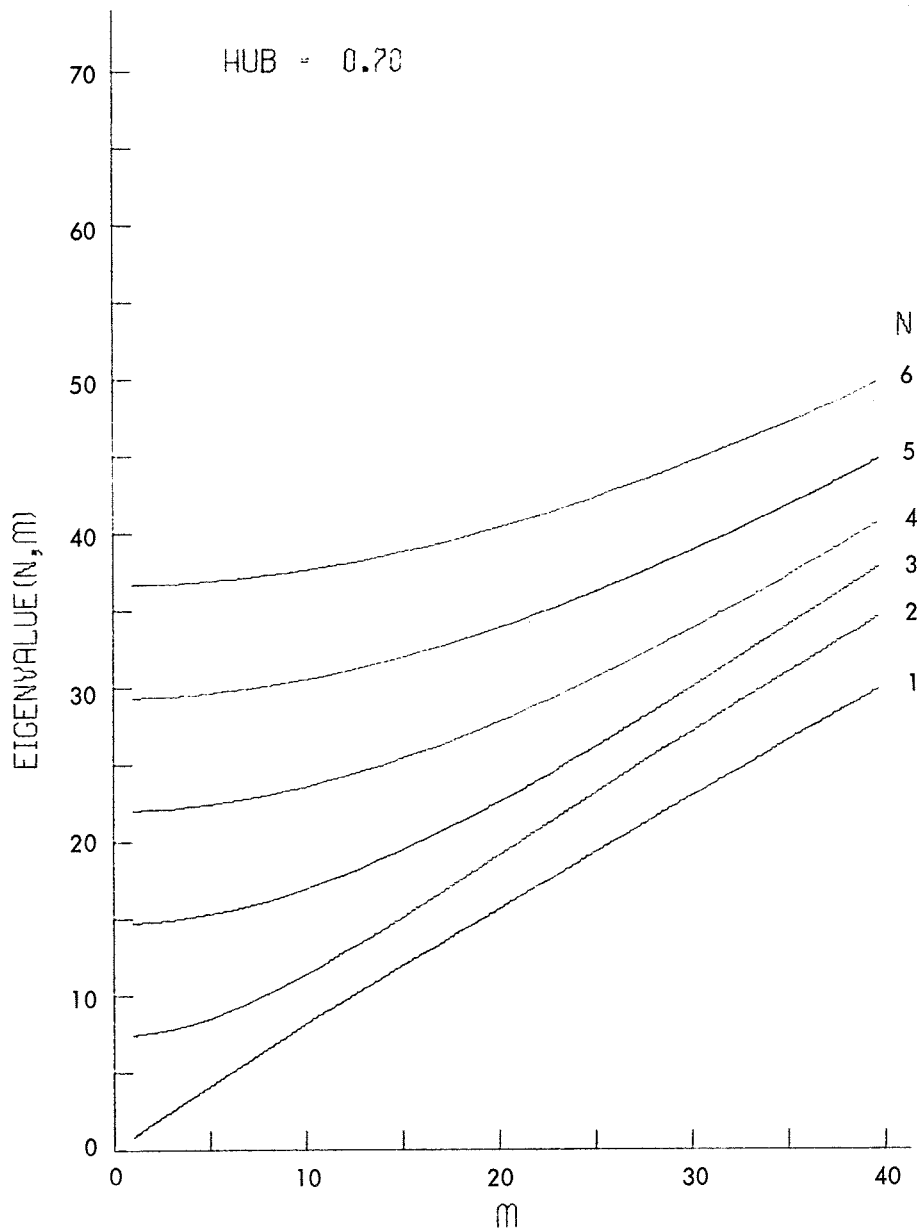


FIGURE 2 - EIGENVALUES FOR A 0.70 HUB RATIO

HYDRONAUTICS, INCORPORATED

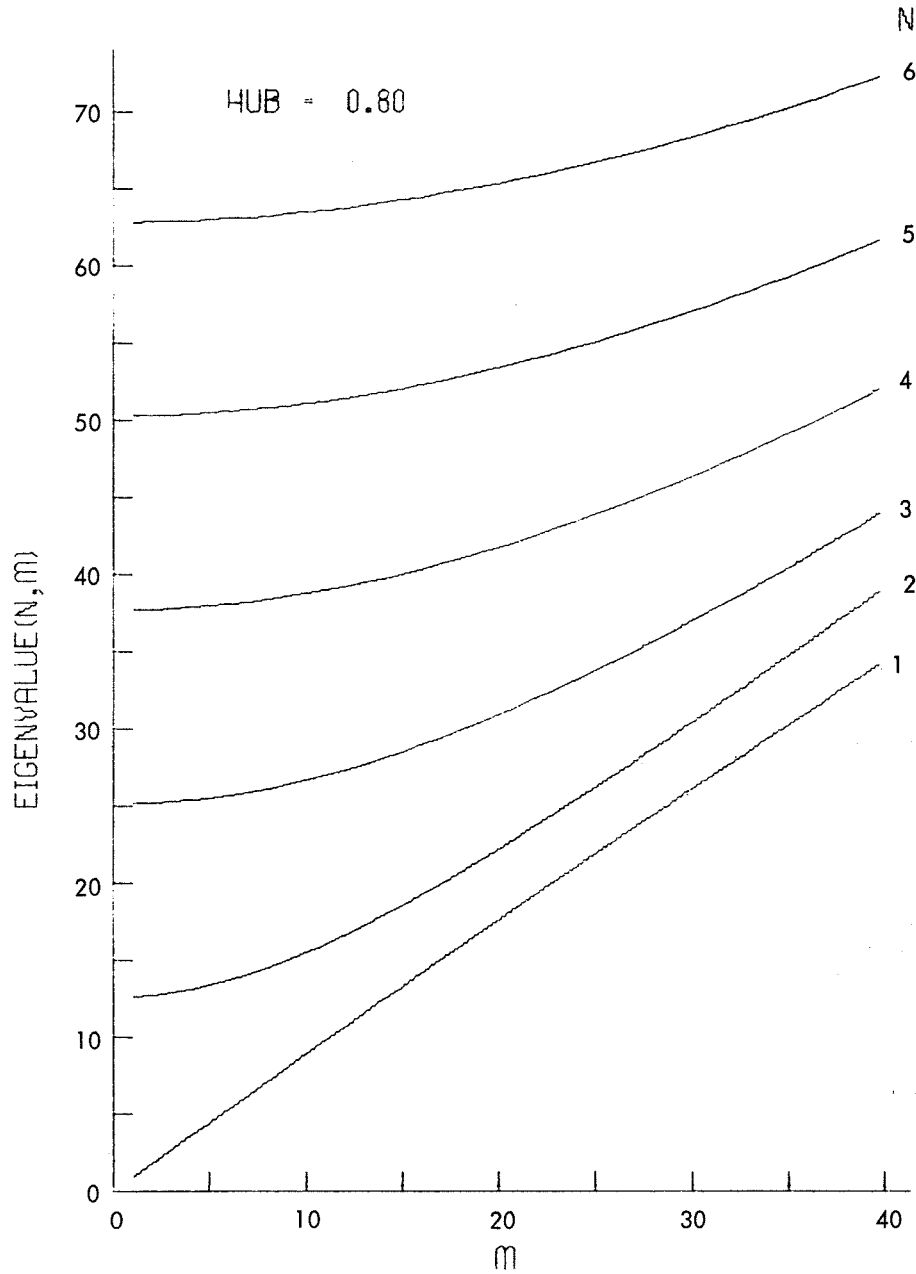


FIGURE 3 - EIGENVALUES FOR A 0.80 HUB RATIO

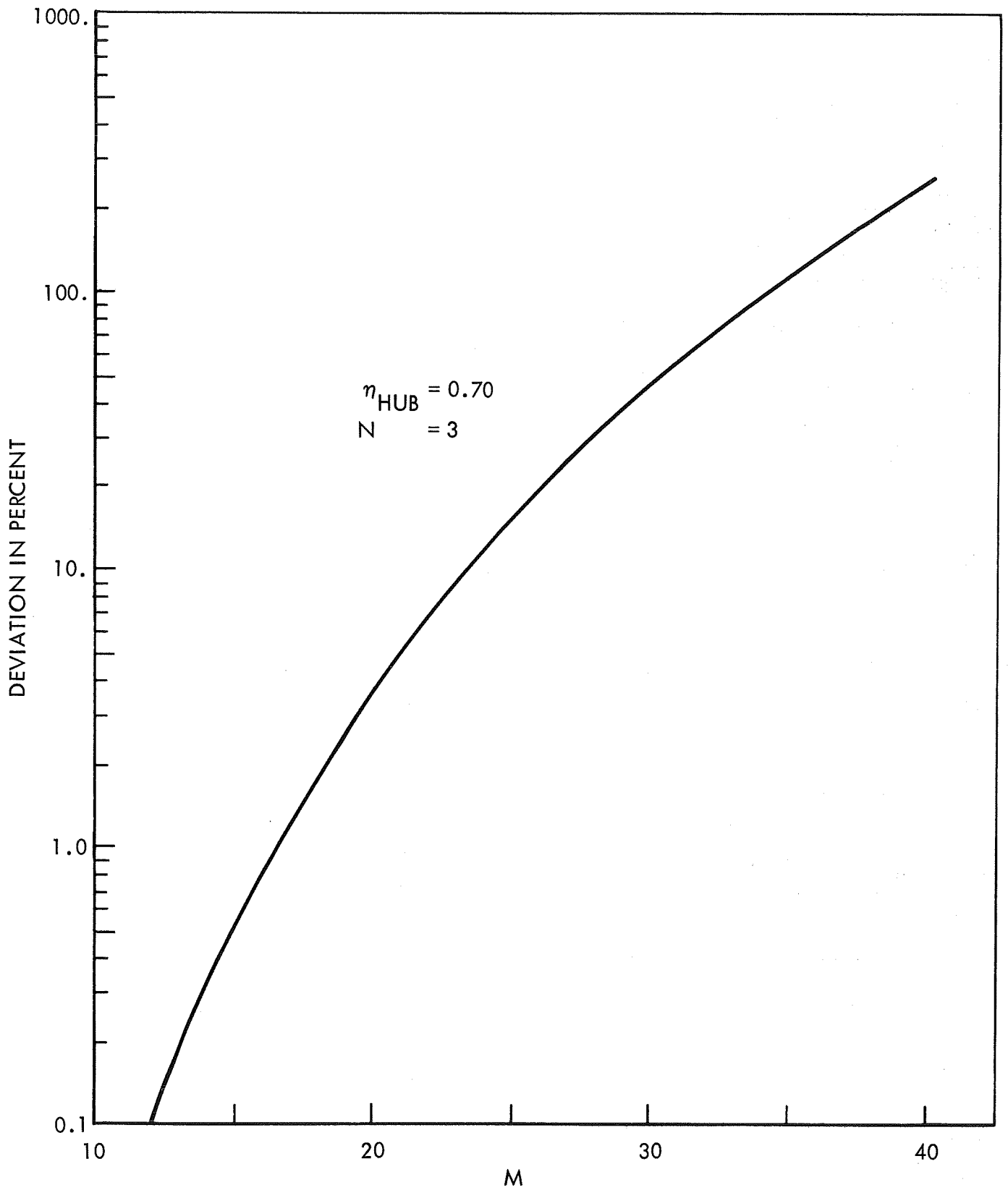


FIGURE 4 - DEVIATION IN PERCENT BETWEEN SERIES APPROXIMATION (REF. 2) TO EIGEN VALUES μ_{NM} AND NUMERICALLY CALCULATED VALUE

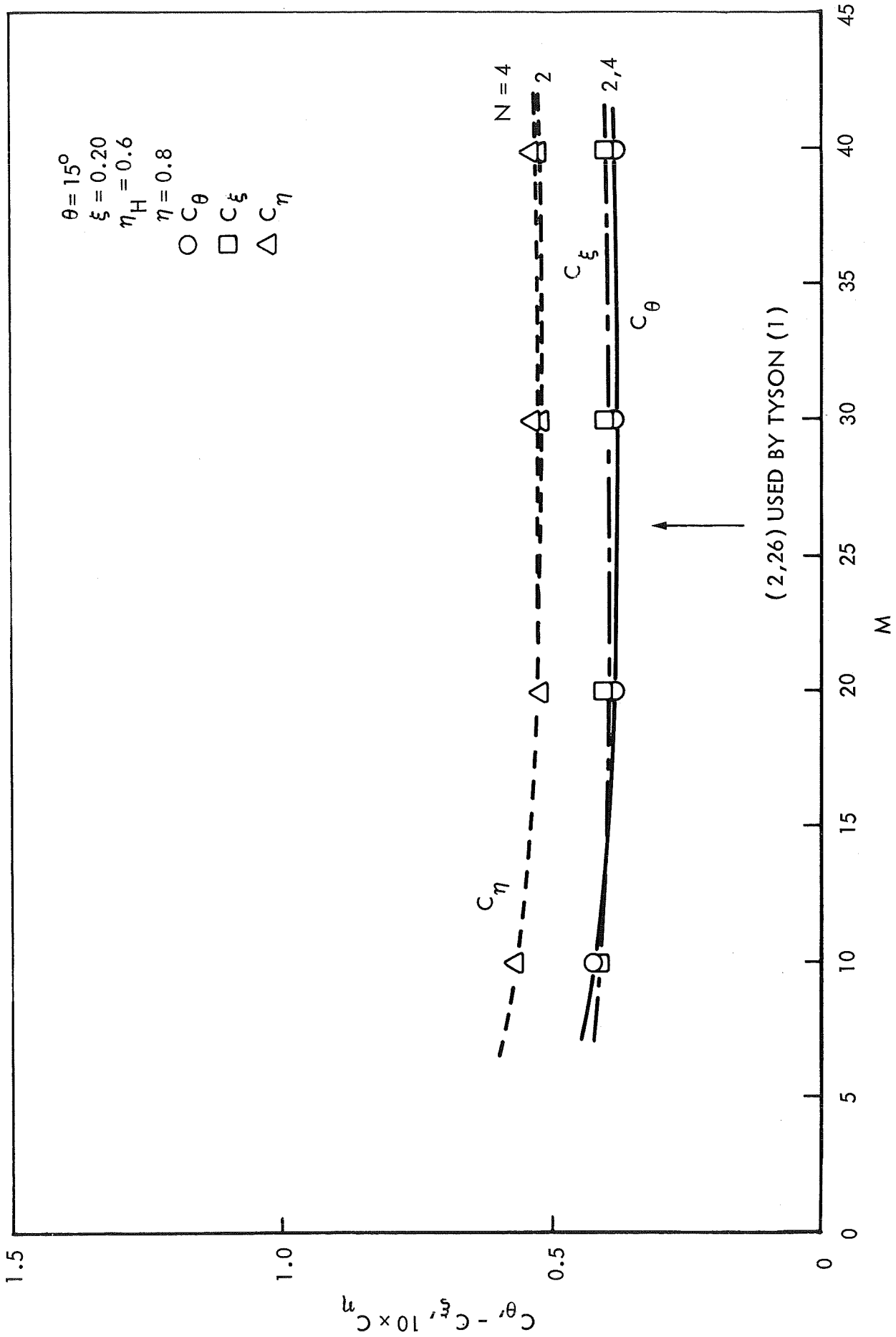


FIGURE 5 - CONVERGENCE OF C_θ , C_ξ , C_η WITH SERIES SIZE (N , M)

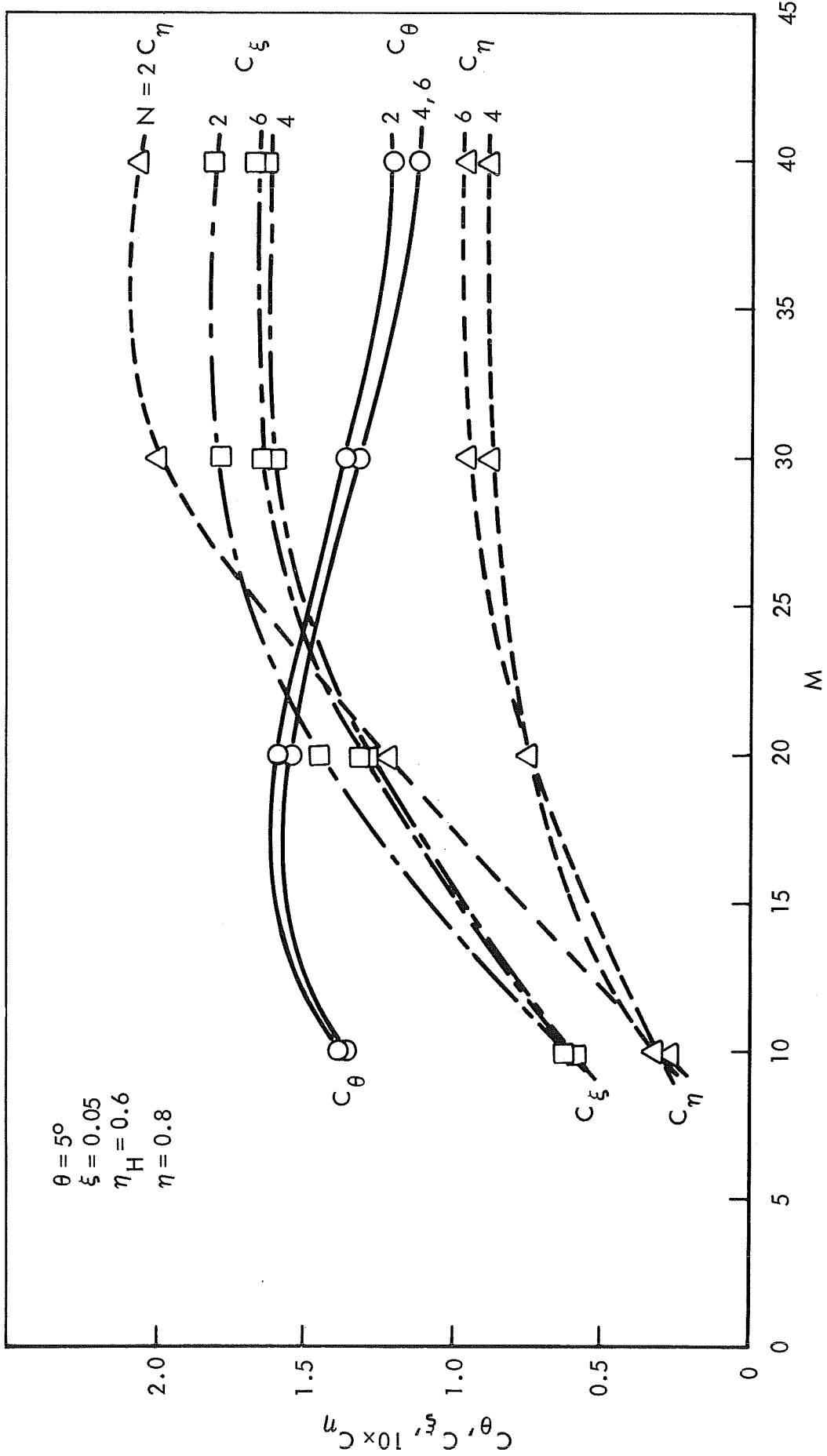


FIGURE 6 - CONVERGENCE OF C_θ , C_ξ AND C_η WITH SERIES SIZE (N, M)

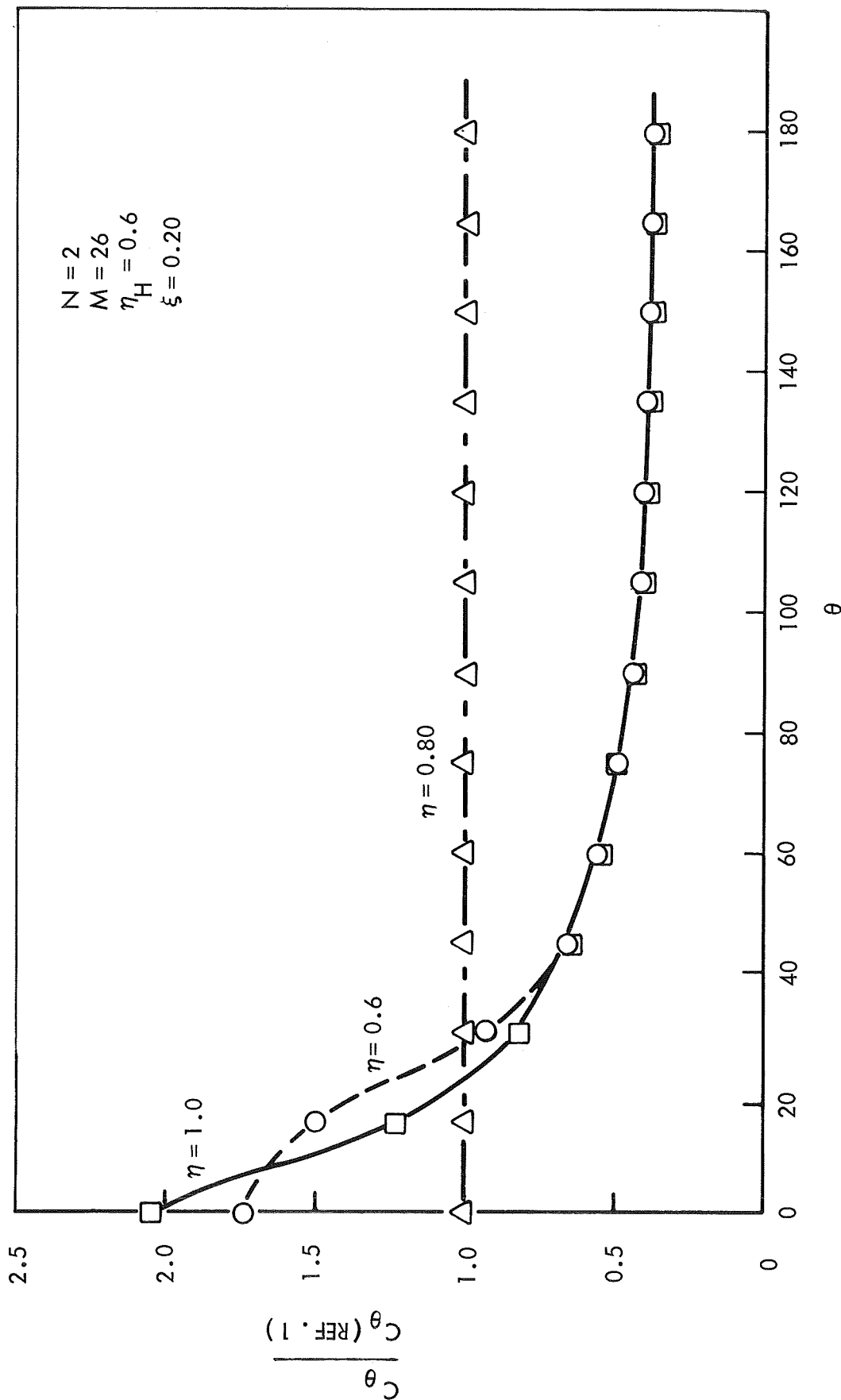


FIGURE 7 (A) - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY TO THE RESULTS OF REFERENCE (1), $N = 2$, $M = 26$, $\xi = 0.200$, $\eta_H = 0.600$

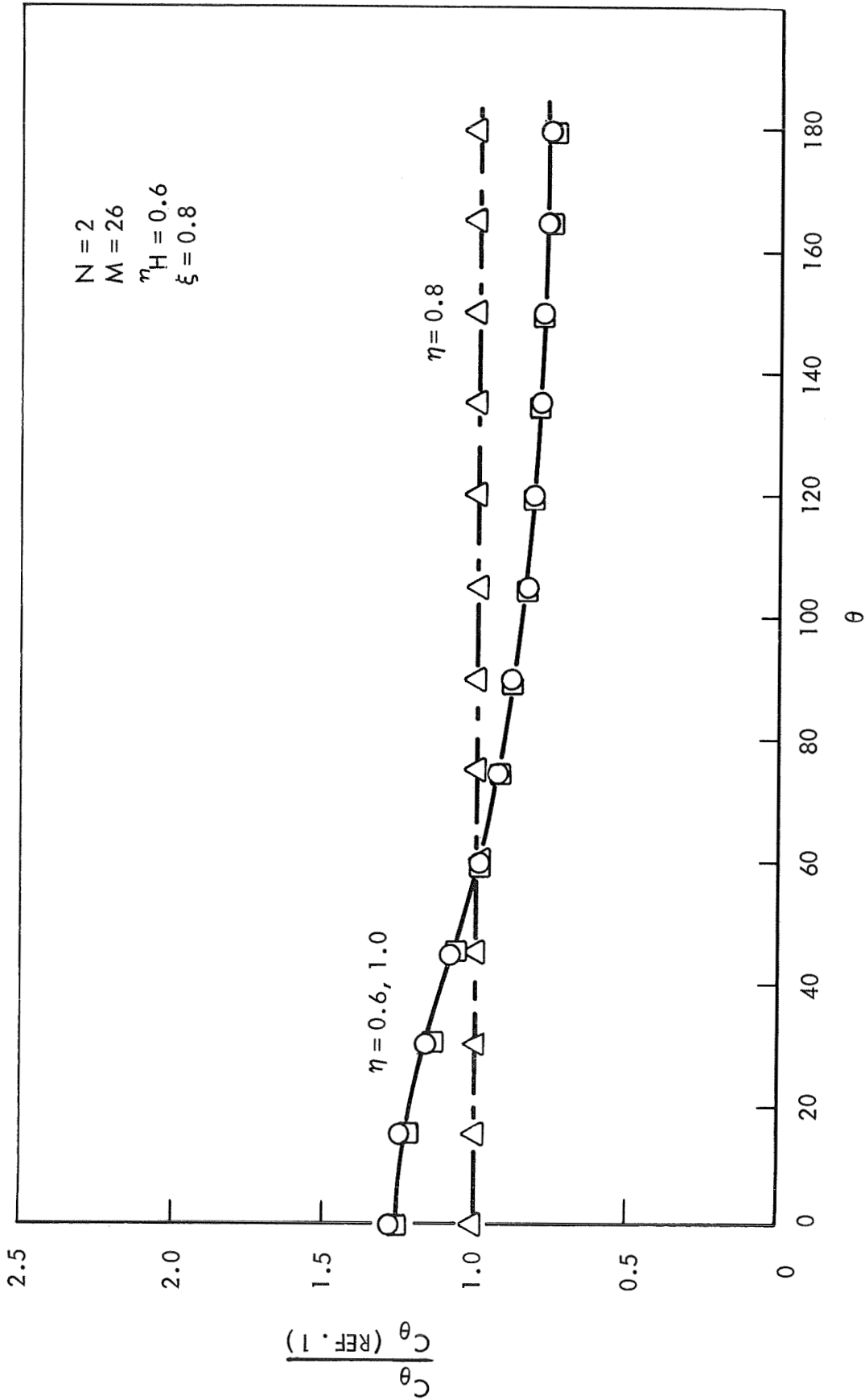


FIGURE 7 (B) - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY TO THE RESULTS OF REF. (1), $N = 2$, $M = 26$, $\xi = 0.800$, $\eta_H = 0.600$

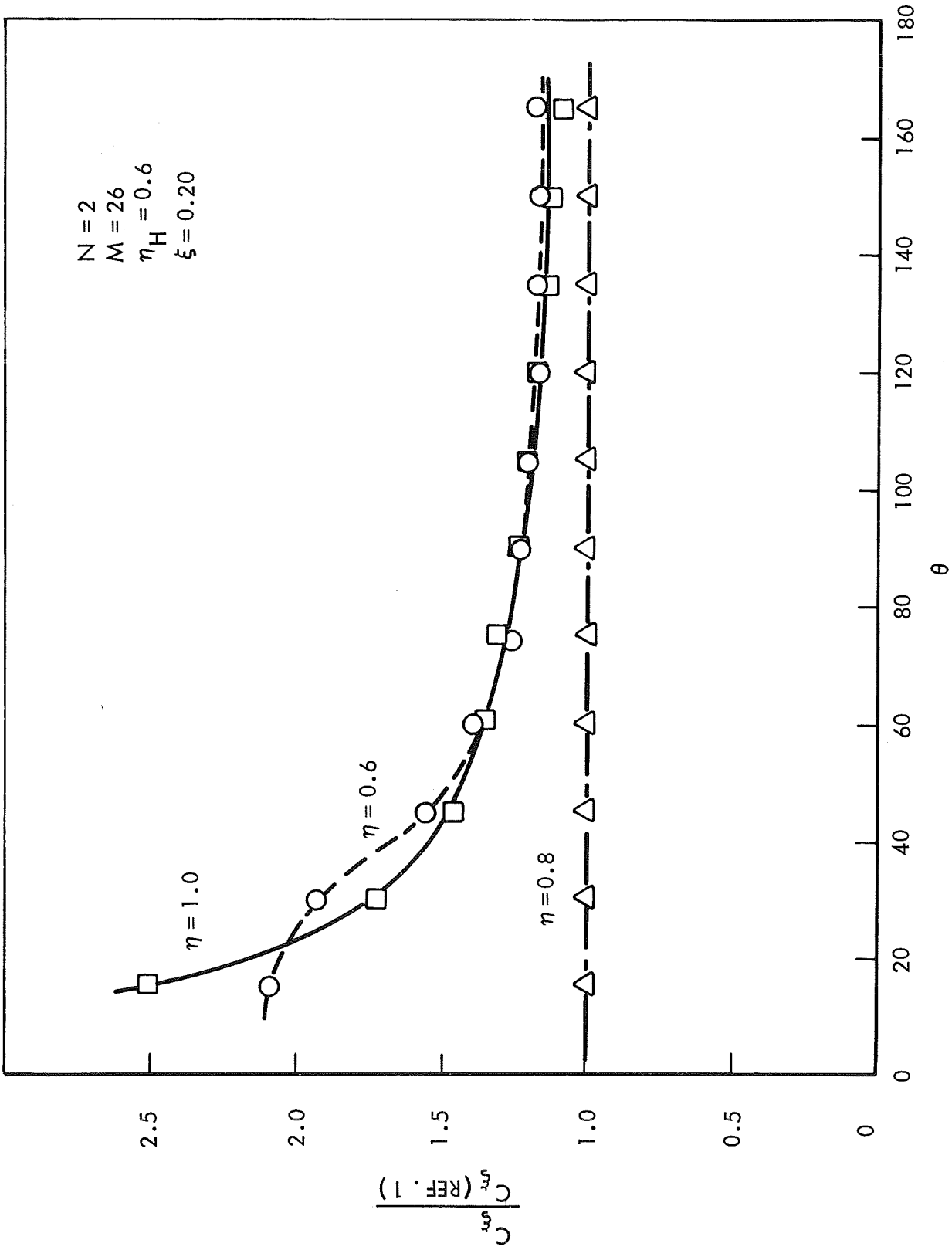


FIGURE 8 (A) - COMPARISON OF THREE-DIMENSIONAL AXIAL VELOCITY TO THE RESULTS OF REF. (1), $N = 2$, $M = 26$, $\xi = 0.200$, $\eta_H = 0.600$

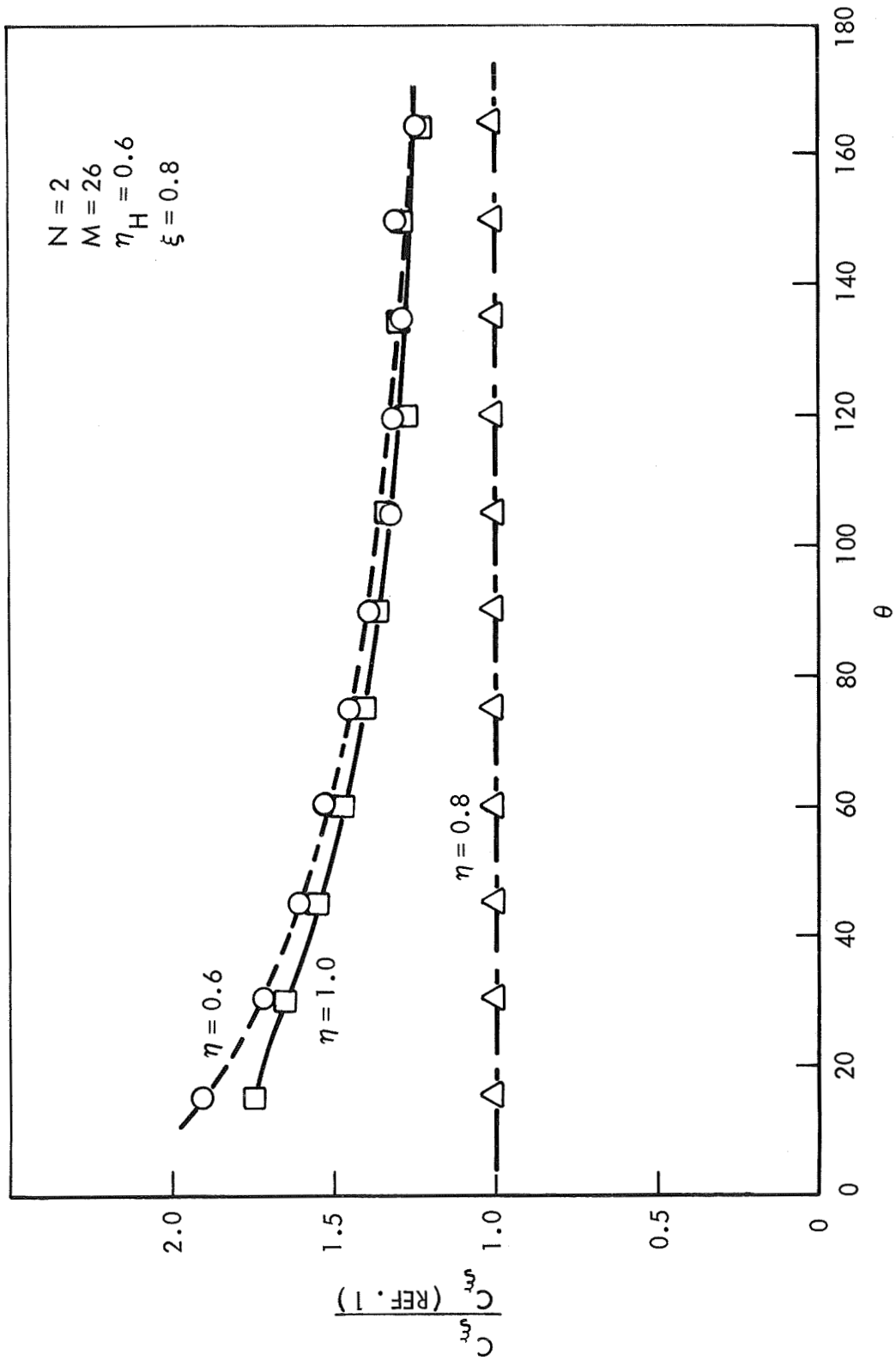


FIGURE 8 (B) - COMPARISON OF THREE-DIMENSIONAL AXIAL VELOCITY TO THE RESULTS OF REF. (1), $N = 2$, $M = 26$, $\xi = 0.800$, $\eta_H = 0.600$

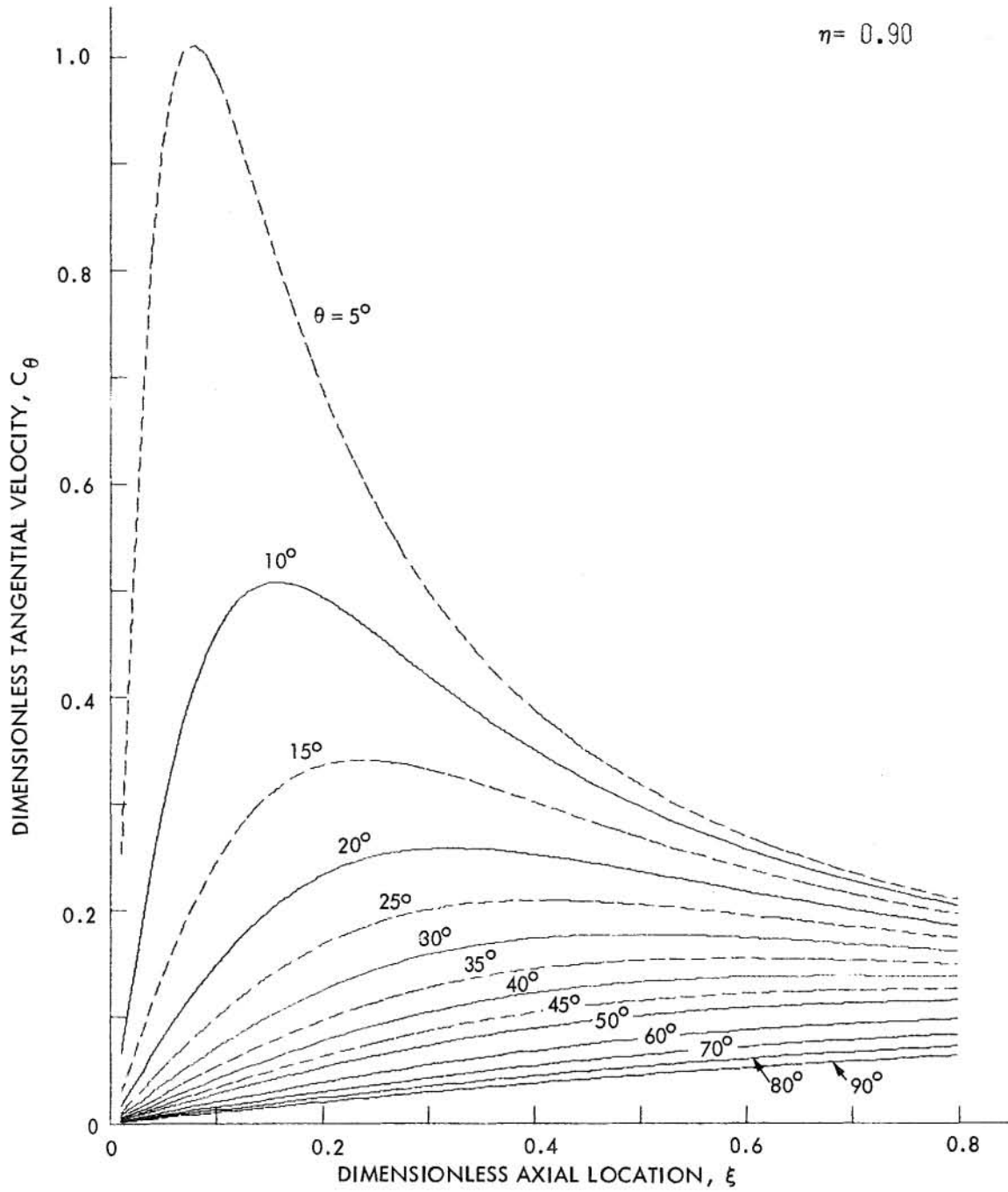


FIGURE 9 - TWO DIMENSIONAL SOLUTION OF TANGENTIAL VELOCITY FOR $\eta = 0.90$.

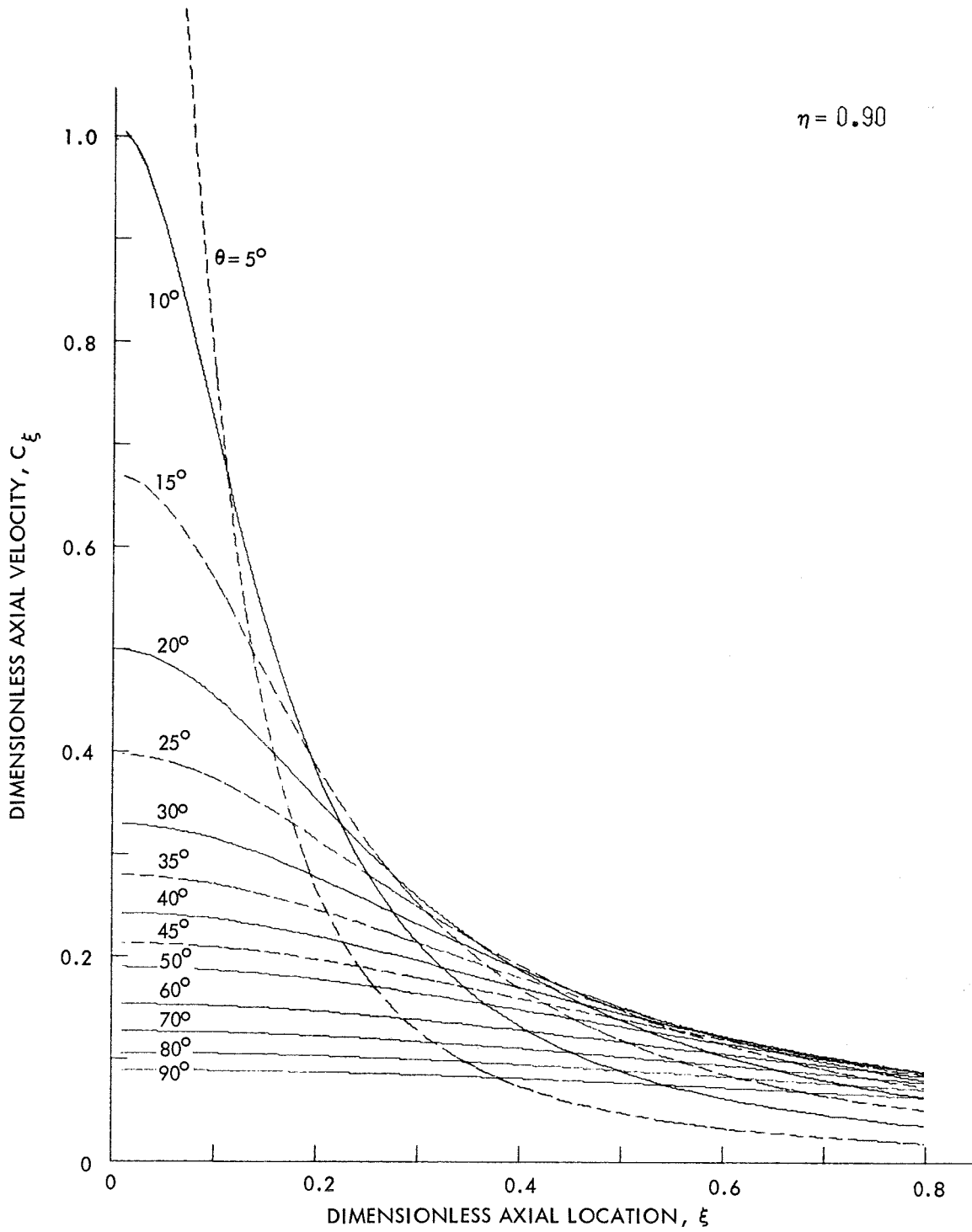


FIGURE 10 - TWO DIMENSIONAL SOLUTION OF AXIAL VELOCITY FOR $\eta = 0.90$

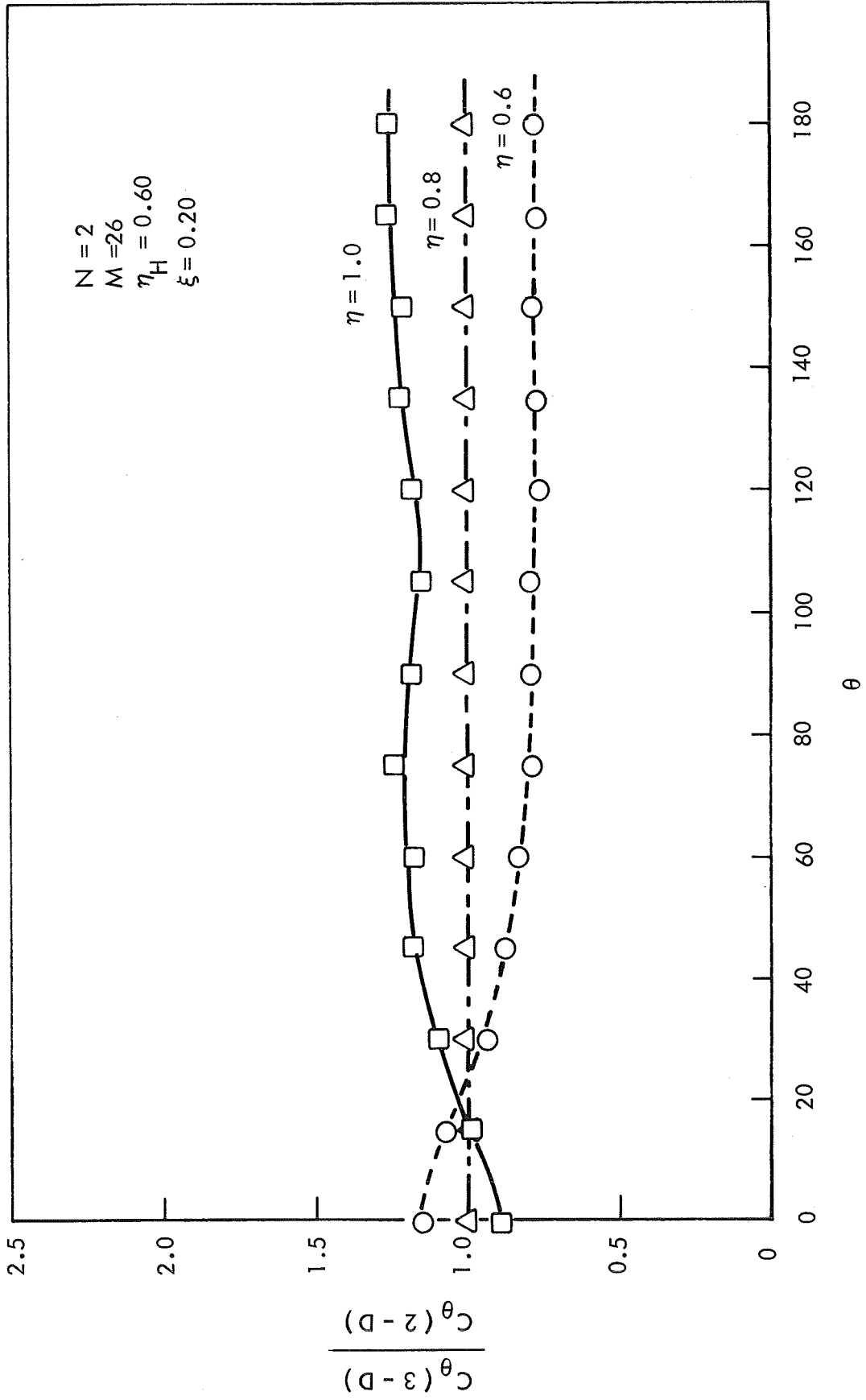


FIGURE 11 (A) - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY THE APPROXIMATE TO TWO-DIMENSIONAL SOLUTION $N = 2$, $M = 26$, $\xi = 0.200$, $\eta_H = 0.600$

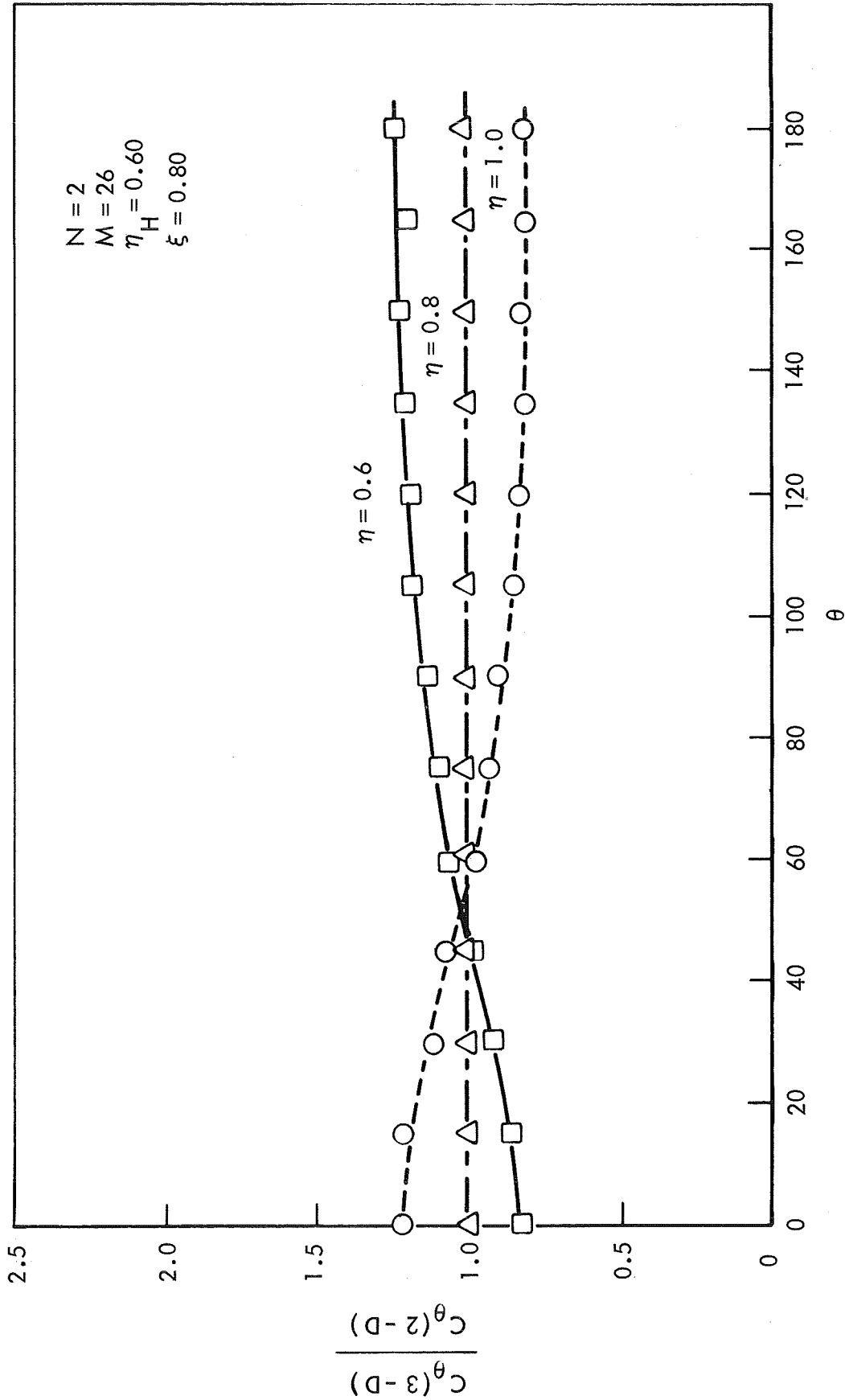


FIGURE 11 (B) - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY THE APPROXIMATE TWO-DIMENSIONAL SOLUTION $N = 2$, $M = 26$, $\xi = 0.800$, $\eta_H = 0.600$

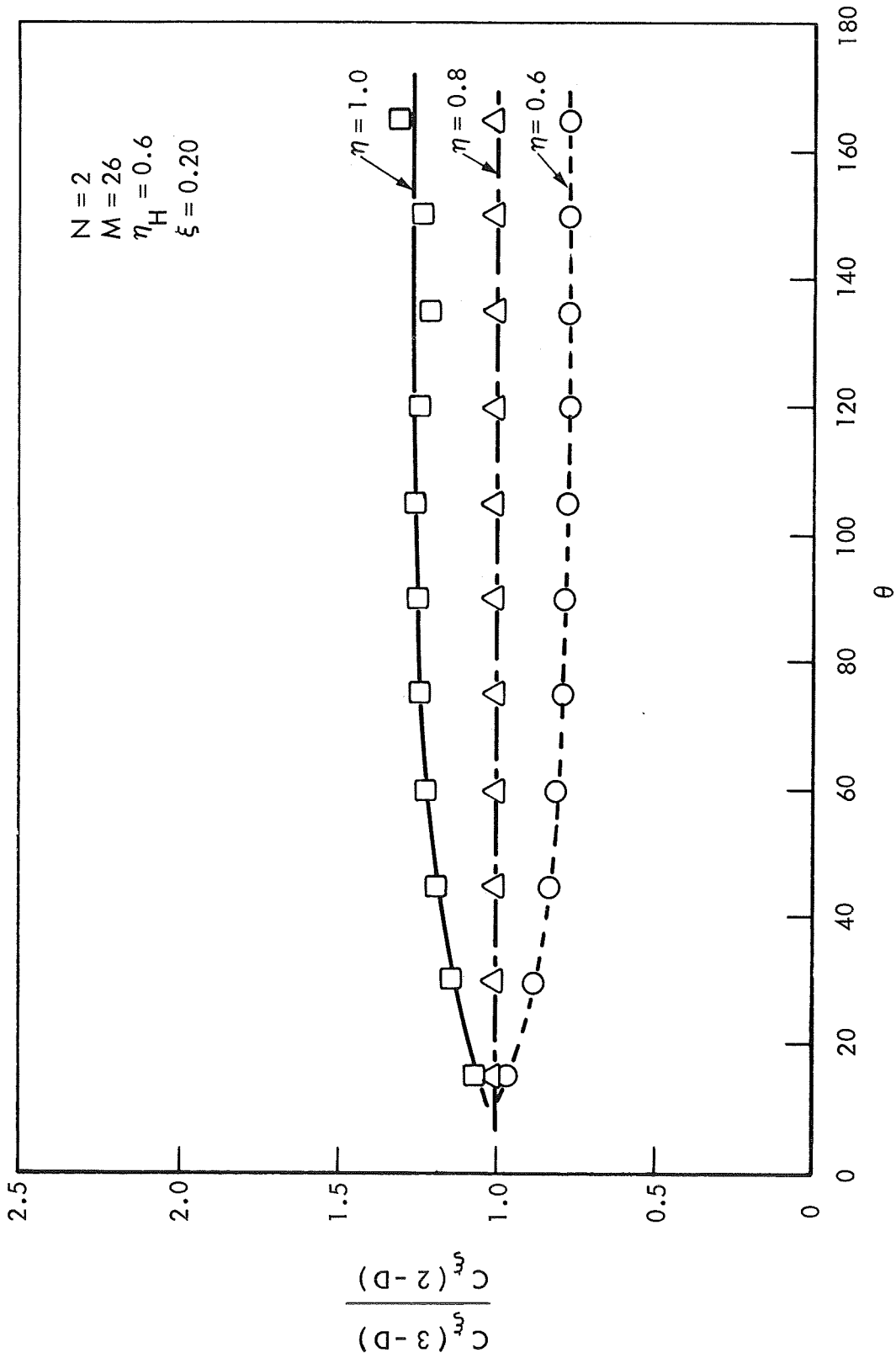


FIGURE 12 (A) - COMPARISON OF THREE-DIMENSIONAL AXIAL VELOCITY TO THE APPROXIMATE TWO-DIMENSIONAL SOLUTION $N=2$, $M=26$, $\xi=0.200$, $\eta_H=0.600$

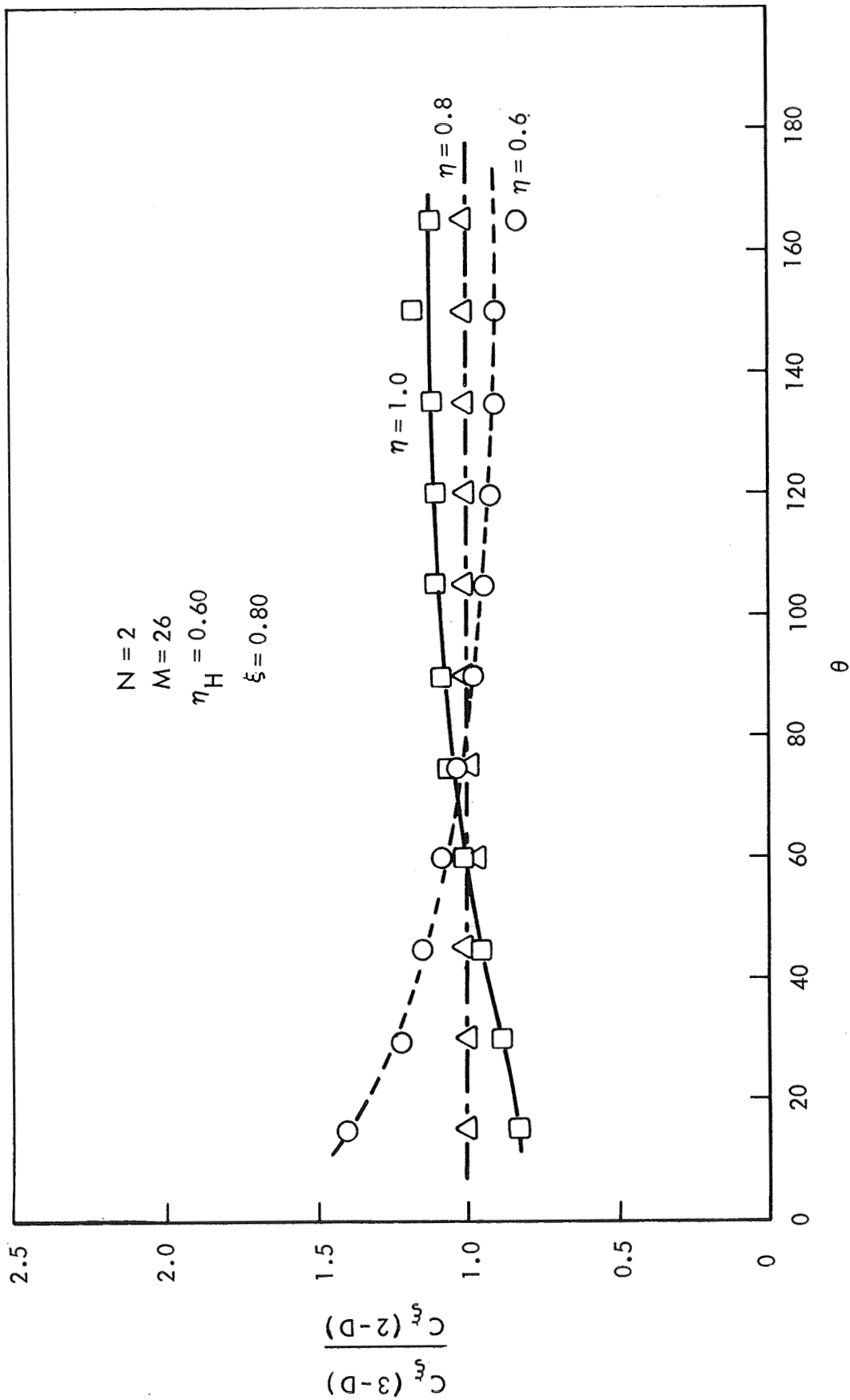


FIGURE 12 (B) - COMPARISON OF THREE DIMENSIONAL AXIAL VELOCITY TO THE APPROXIMATE TWO-DIMENSIONAL SOLUTION, $N = 2$, $M = 26$, $\xi = 0.800$, $\eta_H = 0.600$

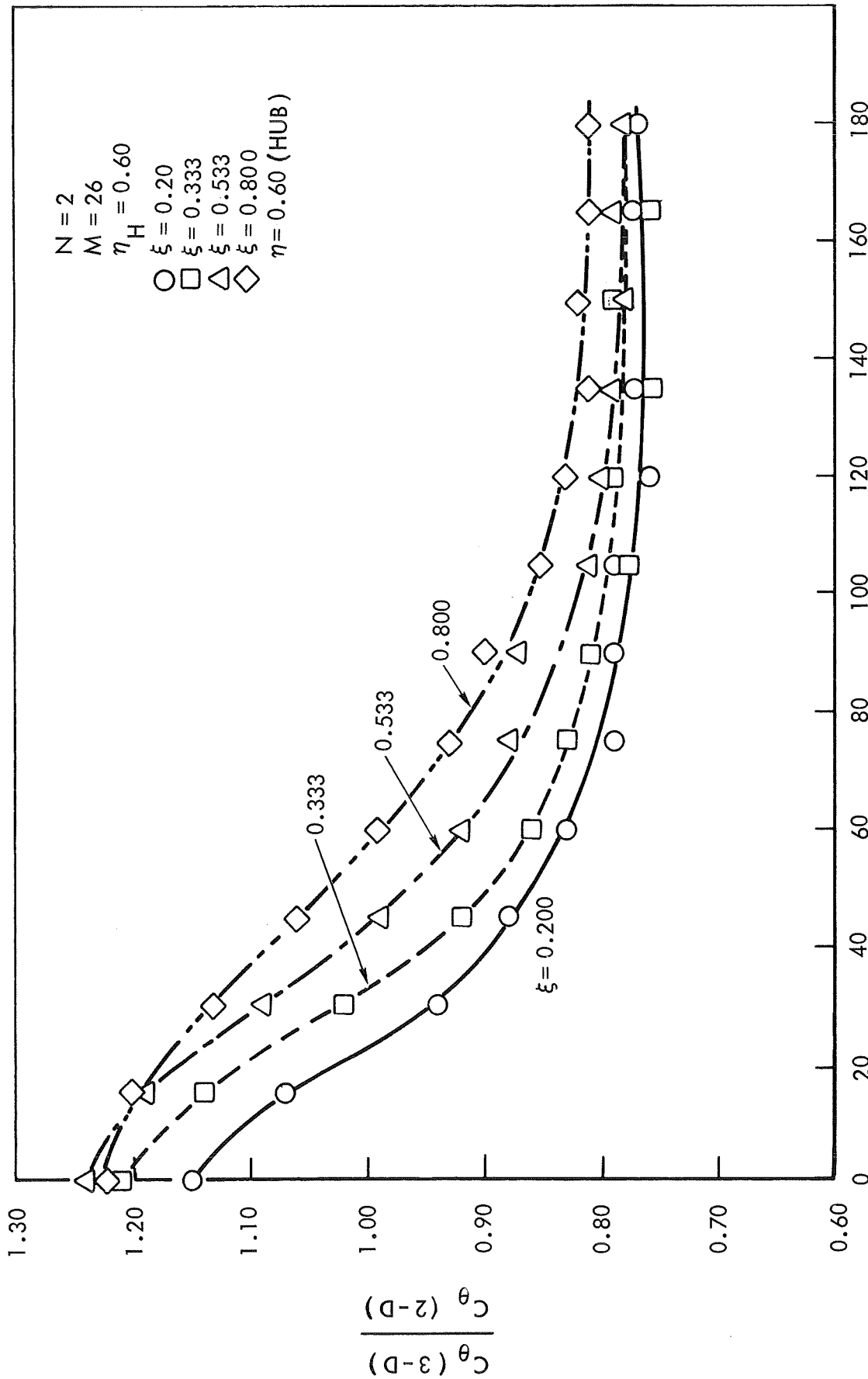


FIGURE 13 - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY TO THE APPROXIMATE
 TWO-DIMENSIONAL SOLUTION AT THE HUB RADIUS FOR VARIOUS AXIAL LOCATIONS
 $\eta_H = 0.600, N = 2, M = 26, \xi = 0.200, 0.333, 0.533, 0.800$

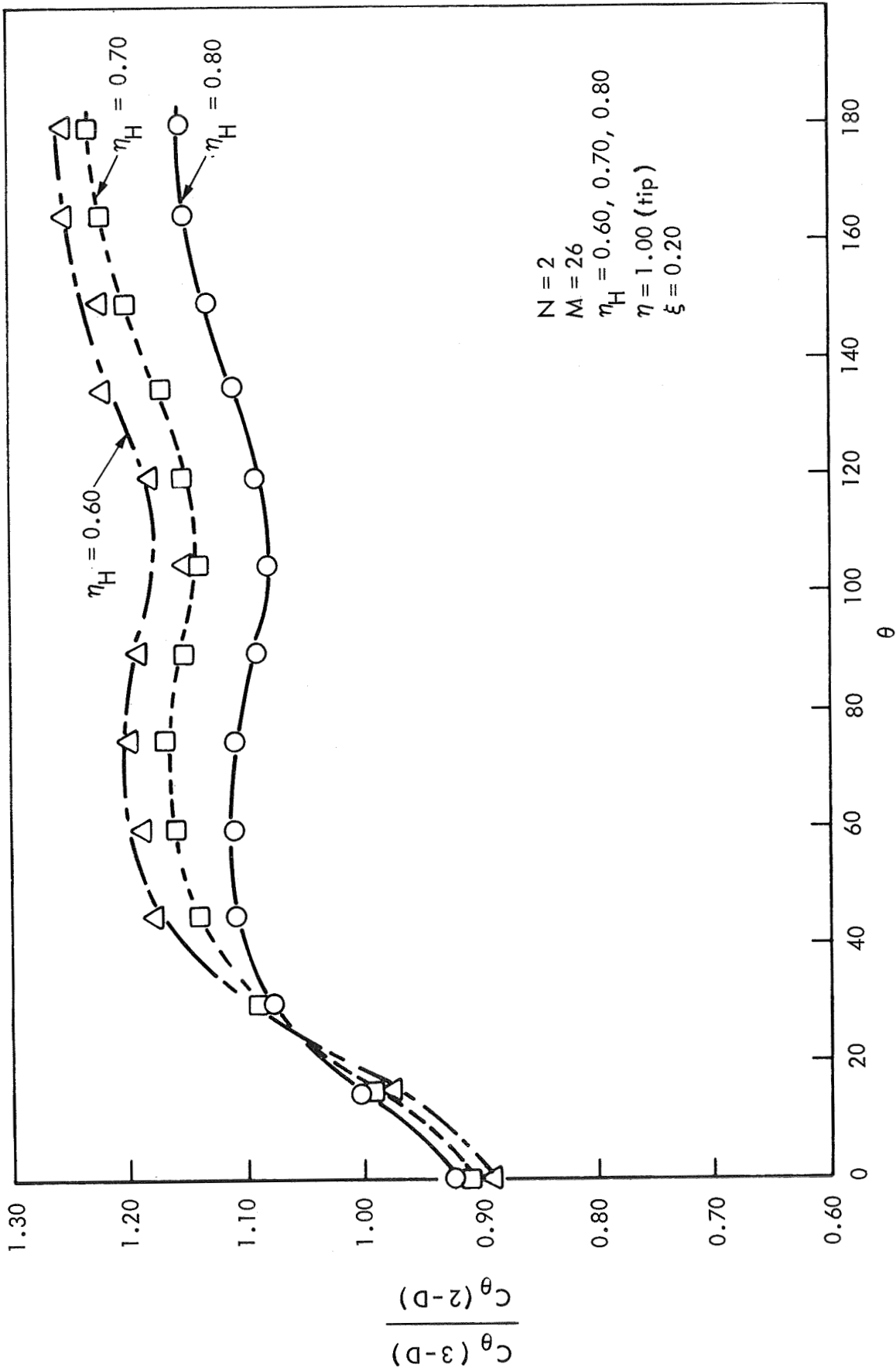


FIGURE 14 - INFLUENCE OF HUB RATIO ON THE RATIO OF THREE DIMENSIONAL TANGENTIAL VELOCITY TO THE APPROXIMATE TWO-DIMENSIONAL SOLUTION AT THE TIP RADIUS

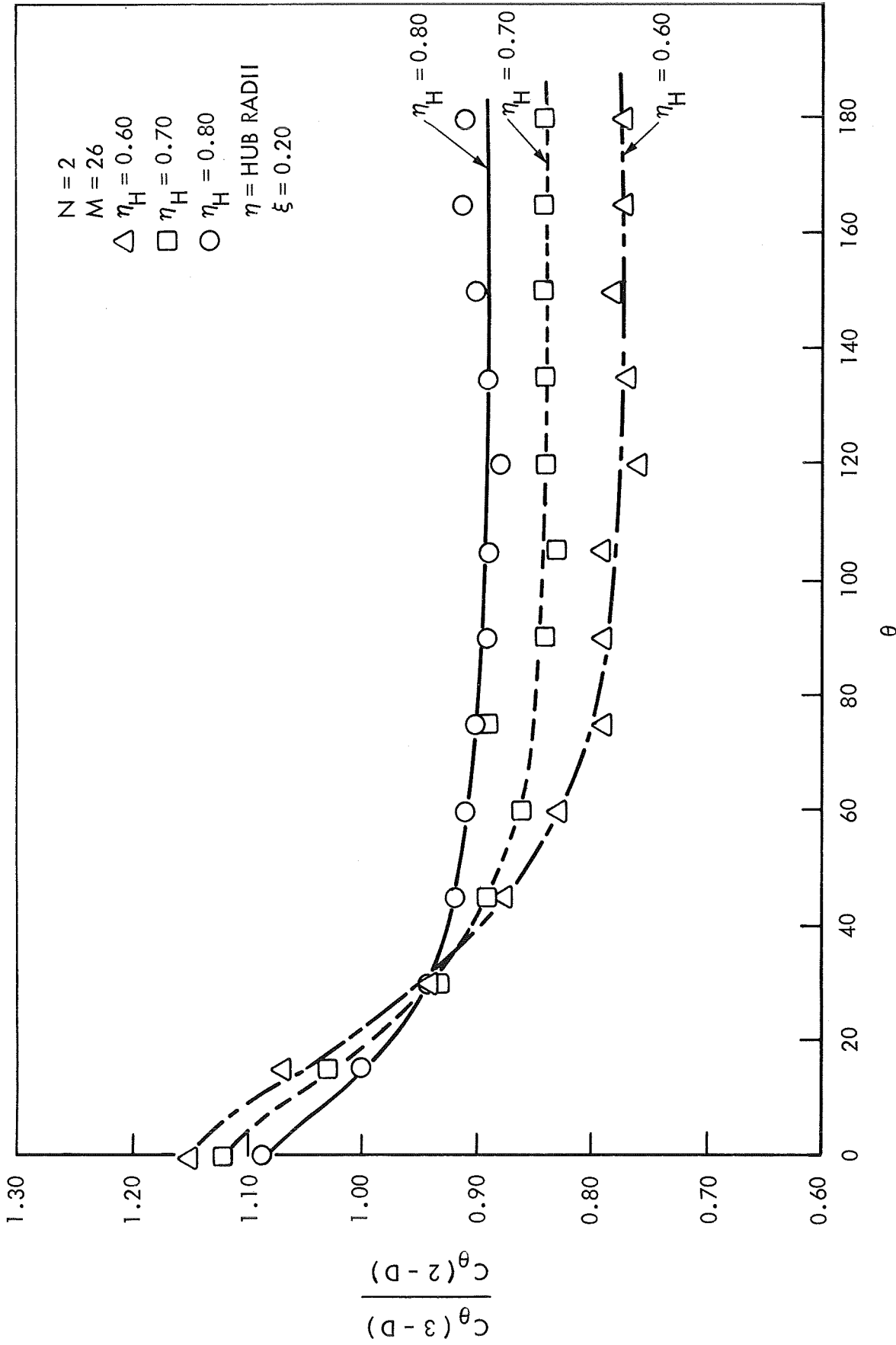


FIGURE 15 - THE INFLUENCE OF HUB RATIO ON THE RATIO OF THREE DIMENSIONAL TANGENTIAL VELOCITY TO THE APPROXIMATE TWO DIMENSIONAL SOLUTION AT THE HUB RADIUS

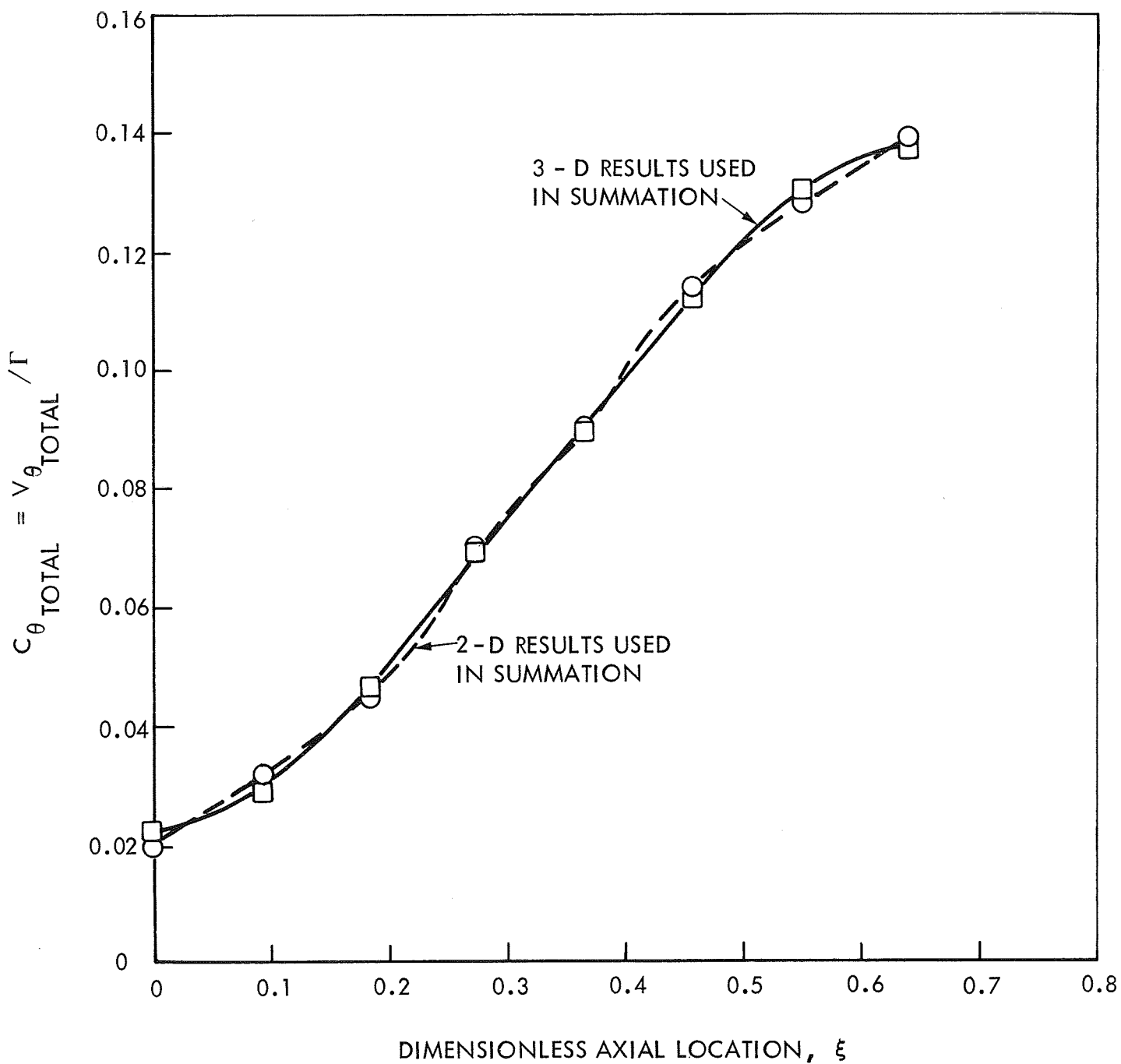


FIGURE 16 - SAMPLE INTERFERENCE STREAMLINE CALCULATION USING BOTH TWO AND THREE DIMENSIONAL RESULTS