TECHNICAL REPORT 703-7

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

By

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December 1969

HYDRONAUTICS, incorporated
research in hydrodynamics

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TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

Simplfication 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

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

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:

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

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)

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

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:

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

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

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

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

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

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

$$\omega = \frac{i\Gamma}{2\pi} \ell n \, z \, (z-a)(z+a)(z-2a)(z+2a) \ldots (z-na)\,(z+na)$$

This may be rewritten

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

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

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

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, 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, η = 1.00
Hub/diameter ratio, η_H = 0.70
Lift parameter, $C_L(C/D)$ = 0.493
Solidity, C_D = 1.795
Chord, c = 9.87"
Axial extent ratio, ξ_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 $C_{\theta_{total}}$ 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 $\bar{m}$ and $\bar{n}$ 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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2. McMahon, J., "On the Roots of the Bessel and Certain Related Functions," Annals of Math. Vol. 9, No. 1, pp 29, 1894.

3. Bowerman, R. D., "The Design of Axial-Flow Pumps," Trans. ASME, Vol. 78, No. 8, 1956.

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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

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

N	M	HUD	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

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

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:

	N	M
$\xi = 0.05 - 0.15$; $\theta = 0^\circ - 180^\circ$	6	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.

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.0500

THETA	CR	CX	CT
0.0	0.000000	0.000000	2.686609
5.0	0.000012	-1.630186	0.807277
10.0	0.000022	-0.809352	0.300014
15.0	0.000025	-0.690362	0.054692
20.0	0.000016	-0.491375	0.125959
25.0	0.000017	-0.392170	0.001589
30.0	0.000015	-0.364675	0.062514
45.0	0.000023	-0.197902	0.024060
90.0	0.000003	-0.082977	0.014452
135.0	-0.000002	-0.034428	0.012736
180.0	0.000000	-0.000004	0.012397

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.1000

THETA	CR	CX	CT
0.0	0.000000	0.000000	1.479260
5.0	0.000011	-0.819745	0.881982
10.0	0.000016	-0.714528	0.397583
15.0	0.000018	-0.583253	0.204065
20.0	0.000016	-0.463762	0.136062
25.0	0.000015	-0.385333	0.082235
30.0	0.000015	-0.330550	0.067307
45.0	0.000018	-0.216519	0.031451
90.0	0.000003	-0.091805	0.010474
135.0	-0.000002	-0.038178	0.006706
180.0	0.000000	-0.000000	0.005931

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.1500

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.980163
5.0	0.000008	-0.460804	0.749424
10.0	0.000013	-0.540513	0.442433
15.0	0.000014	-0.487805	0.267111
20.0	0.000014	-0.417333	0.175757
25.0	0.000014	-0.358067	0.121845
30.0	0.000014	-0.310307	0.090835
45.0	0.000015	-0.213349	0.044865
90.0	0.000003	-0.092199	0.014019
135.0	-0.000001	-0.038480	0.008360
180.0	0.000000	-0.000000	0.007181

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.2000

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.725004
5.0	0.000006	-0.284533	0.619491
10.0	0.000010	-0.396740	0.434389
15.0	0.000012	-0.398404	0.293852
15.0	0.000012	-0.396459	0.293933
20.0	0.000012	-0.365454	0.205814
25.0	0.000013	-0.324398	0.147679
30.0	0.000013	-0.287288	0.113377
45.0	0.000013	-0.205958	0.058513
90.0	0.000003	-0.091620	0.018100
135.0	-0.000001	-0.037971	0.010784
180.0	0.000000	0.000000	0.009654

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.4000

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.353161
5.0	0.000002	-0.074839	0.340124
10.0	0.000004	-0.134058	0.306611
15.0	0.000006	-0.171474	0.264187
15.0	0.000006	-0.171469	0.264187
20.0	0.000007	-0.189735	0.222274
25.0	0.000008	-0.194652	0.185462
30.0	0.000008	-0.191475	0.154937
45.0	0.000009	-0.163498	0.094570
90.0	0.000003	-0.084304	0.034880
135.0	-0.000000	-0.036483	0.021402
180.0	0.000000	0.000000	0.018454

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.6000

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.237116
5.0	0.000001	-0.032167	0.233448
10.0	0.000002	-0.061186	0.223161
15.0	0.000003	-0.084861	0.208066
15.0	0.000003	-0.084861	0.208066
20.0	0.000004	-0.102339	0.190337
25.0	0.000005	-0.113889	0.171868
30.0	0.000005	-0.120411	0.153988
45.0	0.000006	-0.120371	0.109580
90.0	0.000003	-0.074462	0.048367
135.0	-0.000000	-0.033745	0.031073
180.0	0.000000	0.000000	0.027068

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.7999

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.182100
5.0	0.000000	-0.017357	0.180601
10.0	0.000001	-0.033732	0.176267
15.0	0.000002	-0.048313	0.169541
15.0	0.000002	-0.048313	0.169541
20.0	0.000002	-0.060571	0.161039
25.0	0.000003	-0.070279	0.151419
30.0	0.000003	-0.077471	0.141283
45.0	0.000004	-0.086469	0.111957
90.0	0.000002	-0.063502	0.058538
135.0	0.000000	-0.030375	0.039687
180.0	0.000000	0.000000	0.035021

RADIAL COORDINATE= 1.0000, AXIAL COORDINATE= 0.9999

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.150688
5.0	0.000000	-0.010601	0.149936
10.0	0.000000	-0.020805	0.147733
15.0	0.000001	-0.030259	0.144223
15.0	0.000001	-0.030259	0.144223
20.0	0.000001	-0.038687	0.139624
25.0	0.000002	-0.045909	0.134191
30.0	0.000002	-0.051843	0.128188
45.0	0.000003	-0.062211	0.109042
90.0	0.000002	-0.052780	0.065757
135.0	0.000000	-0.026698	0.047135
180.0	-0.000000	0.000000	0.042192

THREE DIMENSIONAL VELOCITY COMPONENTS FOR $\eta = 1.00$, $\eta_H = 0.700$

```
RADIAL COORDINATE= 0.9250, AXIAL COORDINATE= 0.0500

THETA=  0.0, CR=  0.000000 CX=  0.000000 CT=  2.810863
THETA=  5.0, CR=  0.067387 CX= -1.628167 CT=  0.903818
THETA= 10.0, CR=  0.021206 CX= -0.832332 CT=  0.326563
THETA= 15.0, CR=  0.015351 CX= -0.697546 CT=  0.071791
THETA= 20.0, CR=  0.006945 CX= -0.497093 CT=  0.131141
THETA= 25.0, CR=  0.003755 CX= -0.396889 CT=  0.008121
THETA= 30.0, CR=  0.004049 CX= -0.365087 CT=  0.064687
THETA= 45.0, CR= -0.000367 CX= -0.200483 CT=  0.025017
THETA= 90.0, CR= -0.000441 CX= -0.083898 CT=  0.014425
THETA=135.0, CR= -0.000223 CX= -0.034816 CT=  0.012550
THETA=180.0, CR=  0.000000 CX= -0.000004 CT=  0.012181

RADIAL COORDINATE= 0.9250, AXIAL COORDINATE= 0.1000

THETA=  0.0, CR=  0.000000 CX=  0.000000 CT=  1.547094
THETA=  5.0, CR=  0.054546 CX= -0.800676 CT=  0.954805
THETA= 10.0, CR=  0.036247 CX= -0.719243 CT=  0.439486
THETA= 15.0, CR=  0.022403 CX= -0.586927 CT=  0.228155
THETA= 20.0, CR=  0.012872 CX= -0.467595 CT=  0.148960
THETA= 25.0, CR=  0.008030 CX= -0.388099 CT=  0.091870
THETA= 30.0, CR=  0.005489 CX= -0.331849 CT=  0.073060
THETA= 45.0, CR=  0.001516 CX= -0.217707 CT=  0.034082
THETA= 90.0, CR=  0.000105 CX= -0.092130 CT=  0.011103
THETA=135.0, CR= -0.000004 CX= -0.038305 CT=  0.007001
THETA=180.0, CR=  0.000000 CX= -0.000000 CT=  0.006162

RADIAL COORDINATE= 0.9250, AXIAL COORDINATE= 0.1500

THETA=  0.0, CR=  0.000000 CX=  0.000000 CT=  1.031814
THETA=  5.0, CR=  0.036899 CX= -0.446821 CT=  0.803141
THETA= 10.0, CR=  0.035453 CX= -0.536361 CT=  0.483889
THETA= 15.0, CR=  0.024828 CX= -0.487989 CT=  0.294299
THETA= 20.0, CR=  0.016116 CX= -0.418891 CT=  0.193318
THETA= 25.0, CR=  0.010591 CX= -0.359563 CT=  0.134080
THETA= 30.0, CR=  0.007145 CX= -0.311447 CT=  0.099429
THETA= 45.0, CR=  0.002510 CX= -0.213994 CT=  0.048859
THETA= 90.0, CR=  0.000320 CX= -0.092328 CT=  0.015151
THETA=135.0, CR=  0.000070 CX= -0.038523 CT=  0.009004
THETA=180.0, CR=  0.000000 CX= -0.000000 CT=  0.007729

RADIAL COORDINATE= 0.9250, AXIAL COORDINATE= 0.2000

THETA=  0.0, CR=  0.000000 CX=  0.000000 CT=  0.767800
THETA=  5.0, CR=  0.024396 CX= -0.275740 CT=  0.662346
THETA= 10.0, CR=  0.029081 CX= -0.390814 CT=  0.471296
THETA= 15.0, CR=  0.023531 CX= -0.396345 CT=  0.321336
THETA= 15.0, CR=  0.023324 CX= -0.394589 CT=  0.321364
THETA= 20.0, CR=  0.017052 CX= -0.365135 CT=  0.225408
THETA= 25.0, CR=  0.011776 CX= -0.324736 CT=  0.161993
THETA= 30.0, CR=  0.009183 CX= -0.288007 CT=  0.123855
THETA= 45.0, CR=  0.003185 CX= -0.206368 CT=  0.063586
THETA= 90.0, CR=  0.000488 CX= -0.091660 CT=  0.019653
THETA=135.0, CR=  0.000072 CX= -0.038031 CT=  0.011688
THETA=180.0, CR=  0.000000 CX=  0.000000 CT=  0.010395

RADIAL COORDINATE= 0.9250, AXIAL COORDINATE= 0.4000

THETA=  0.0, CR=  0.000000 CX=  0.000000 CT=  0.378715
THETA=  5.0, CR=  0.005688 CX= -0.073350 CT=  0.365200
THETA= 10.0, CR=  0.009467 CX= -0.131899 CT=  0.330219
THETA= 15.0, CR=  0.010825 CX= -0.169468 CT=  0.285470
THETA= 15.0, CR=  0.010823 CX= -0.169465 CT=  0.285469
THETA= 20.0, CR=  0.010424 CX= -0.188251 CT=  0.240795
THETA= 25.0, CR=  0.009164 CX= -0.193699 CT=  0.201234
THETA= 30.0, CR=  0.007674 CX= -0.190927 CT=  0.168240
THETA= 45.0, CR=  0.004101 CX= -0.163479 CT=  0.102670
THETA= 90.0, CR=  0.000783 CX= -0.084355 CT=  0.037771
THETA=135.0, CR=  0.000206 CX= -0.036501 CT=  0.023153
THETA=180.0, CR=  0.000000 CX=  0.000000 CT=  0.019959

RADIAL COORDINATE= 0.9250, AXIAL COORDINATE= 0.6000

THETA=  0.0, CR=  0.000000 CX=  0.000000 CT=  0.255362
THETA=  5.0, CR=  0.001891 CX= -0.031799 CT=  0.251486
THETA= 10.0, CR=  0.003459 CX= -0.060554 CT=  0.240592
THETA= 15.0, CR=  0.004508 CX= -0.084114 CT=  0.224554
THETA= 15.0, CR=  0.004508 CX= -0.084114 CT=  0.224555
THETA= 20.0, CR=  0.005015 CX= -0.101609 CT=  0.205642
THETA= 25.0, CR=  0.005078 CX= -0.113257 CT=  0.185861
THETA= 30.0, CR=  0.004842 CX= -0.119907 CT=  0.166645
THETA= 45.0, CR=  0.003484 CX= -0.120187 CT=  0.118699
THETA= 90.0, CR=  0.000956 CX= -0.074481 CT=  0.052355
THETA=135.0, CR=  0.000277 CX= -0.033757 CT=  0.033613
THETA=180.0, CR= -0.000000 CX=  0.000000 CT=  0.029275

RADIAL COORDINATE= 0.9250, AXIAL COORDINATE= 0.7999

THETA=  0.0, CR=  0.000000 CX=  0.000000 CT=  0.196450
THETA=  5.0, CR=  0.000813 CX= -0.017234 CT=  0.194851
THETA= 10.0, CR=  0.001545 CX= -0.033507 CT=  0.190225
THETA= 15.0, CR=  0.002133 CX= -0.048020 CT=  0.183037
THETA= 15.0, CR=  0.002133 CX= -0.048020 CT=  0.183037
THETA= 20.0, CR=  0.002546 CX= -0.060246 CT=  0.173935
THETA= 25.0, CR=  0.002785 CX= -0.069956 CT=  0.163619
THETA= 30.0, CR=  0.002871 CX= -0.077173 CT=  0.152728
THETA= 45.0, CR=  0.002553 CX= -0.086293 CT=  0.121127
THETA= 90.0, CR=  0.000985 CX= -0.063497 CT=  0.063343
THETA=135.0, CR=  0.000319 CX= -0.030381 CT=  0.042928
THETA=180.0, CR= -0.000000 CX=  0.000000 CT=  0.037876

RADIAL COORDINATE= 0.9250, AXIAL COORDINATE= 0.9999

THETA=  0.0, CR=  0.000000 CX=  0.000000 CT=  0.162696
THETA=  5.0, CR=  0.000416 CX= -0.010550 CT=  0.161890
THETA= 10.0, CR=  0.000805 CX= -0.020709 CT=  0.159528
THETA= 15.0, CR=  0.001144 CX= -0.030127 CT=  0.155763
THETA= 15.0, CR=  0.001144 CX= -0.030127 CT=  0.155763
THETA= 20.0, CR=  0.001417 CX= -0.038531 CT=  0.150826
THETA= 25.0, CR=  0.001618 CX= -0.045743 CT=  0.144989
THETA= 30.0, CR=  0.001747 CX= -0.051676 CT=  0.138534
THETA= 45.0, CR=  0.001788 CX= -0.062080 CT=  0.117908
THETA= 90.0, CR=  0.000918 CX= -0.052761 CT=  0.071134
THETA=135.0, CR=  0.000333 CX= -0.026698 CT=  0.050980
THETA=180.0, CR= -0.000000 CX=  0.000000 CT=  0.045630
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THREE DIMENSIONAL VELOCITY COMPONENTS FOR $\eta = 0.925$, $\eta_H = 0.700$

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.0500

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 2.889848
THETA= 5.0,	CR= 0.084240	CX= -1.635649	CT= 1.026419
THETA= 10.0,	CR= 0.033680	CX= -0.878498	CT= 0.367169
THETA= 15.0,	CR= 0.022508	CX= -0.716503	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= 0.019660
THETA= 30.0,	CR= 0.005562	CX= -0.367738	CT= 0.066761
THETA= 45.0,	CR= 0.000150	CX= -0.204615	CT= 0.025974
THETA= 90.0,	CR= -0.000354	CX= -0.085090	CT= 0.013930
THETA=135.0,	CR= -0.000178	CX= -0.035271	CT= 0.011856
THETA=180.0,	CR= 0.000000	CX= -0.000004	CT= 0.011427

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.1000

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= 0.053015	CX= -0.727781	CT= 0.499328
THETA= 15.0,	CR= 0.033633	CX= -0.596280	CT= 0.265148
THETA= 20.0,	CR= 0.019941	CX= -0.476539	CT= 0.168603
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= 45.0,	CR= 0.002501	CX= -0.220011	CT= 0.037565
THETA= 90.0,	CR= 0.000248	CX= -0.092643	CT= 0.011782
THETA=135.0,	CR= 0.000038	CX= -0.036485	CT= 0.007270
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= 0.050607	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= 45.0,	CR= 0.003852	CX= -0.215464	CT= 0.054164
THETA= 90.0,	CR= 0.000499	CX= -0.092591	CT= 0.016513
THETA=135.0,	CR= 0.000115	CX= -0.038600	CT= 0.009765
THETA=180.0,	CR= 0.000000	CX= -0.000000	CT= 0.008361

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= 0.701991
THETA= 10.0,	CR= 0.041189	CX= -0.377600	CT= 0.515282
THETA= 15.0,	CR= 0.034669	CX= -0.391315	CT= 0.358187
THETA= 15.0,	CR= 0.034354	CX= -0.390069	CT= 0.358075
THETA= 20.0,	CR= 0.025618	CX= -0.364216	CT= 0.252663
THETA= 25.0,	CR= 0.017902	CX= -0.326115	CT= 0.182290
THETA= 30.0,	CR= 0.012489	CX= -0.289679	CT= 0.138285
THETA= 45.0,	CR= 0.004827	CX= -0.207372	CT= 0.070154
THETA= 90.0,	CR= 0.000720	CX= -0.091770	CT= 0.021577
THETA=135.0,	CR= 0.000118	CX= -0.038164	CT= 0.012791
THETA=180.0,	CR= 0.000000	CX= 0.000000	CT= 0.011222

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.4000

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 0.404416
THETA= 5.0,	CR= 0.008047	CX= -0.070008	CT= 0.391077
THETA= 10.0,	CR= 0.013555	CX= -0.126952	CT= 0.356032
THETA= 15.0,	CR= 0.015722	CX= -0.164764	CT= 0.310141
THETA= 15.0,	CR= 0.015721	CX= -0.164764	CT= 0.310139
THETA= 20.0,	CR= 0.015333	CX= -0.184691	CT= 0.263214
THETA= 25.0,	CR= 0.013607	CX= -0.191372	CT= 0.220839
THETA= 30.0,	CR= 0.011465	CX= -0.189569	CT= 0.184996
THETA= 45.0,	CR= 0.006165	CX= -0.163423	CT= 0.112873
THETA= 90.0,	CR= 0.001173	CX= -0.084479	CT= 0.041265
THETA=135.0,	CR= 0.000308	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= 0.275377
THETA= 5.0,	CR= 0.002741	CX= -0.030941	CT= 0.271380
THETA= 10.0,	CR= 0.005030	CX= -0.059071	CT= 0.260097
THETA= 15.0,	CR= 0.006588	CX= -0.082350	CT= 0.243355
THETA= 15.0,	CR= 0.006588	CX= -0.082350	CT= 0.243355
THETA= 20.0,	CR= 0.007368	CX= -0.099871	CT= 0.223427
THETA= 25.0,	CR= 0.007498	CX= -0.111739	CT= 0.202389
THETA= 30.0,	CR= 0.007179	CX= -0.118691	CT= 0.181781
THETA= 45.0,	CR= 0.005204	CX= -0.119739	CT= 0.129786
THETA= 90.0,	CR= 0.001431	CX= -0.074527	CT= 0.057148
THETA=135.0,	CR= 0.000415	CX= -0.033784	CT= 0.036634
THETA=180.0,	CR= -0.000000	CX= 0.000000	CT= 0.031892

RADIAL COORDINATE= 0.8500, AXIAL COORDINATE= 0.7999

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 0.212709
THETA= 5.0,	CR= 0.001193	CX= -0.016944	CT= 0.211024
THETA= 10.0,	CR= 0.002269	CX= -0.032973	CT= 0.206140
THETA= 15.0,	CR= 0.003137	CX= -0.047322	CT= 0.198530
THETA= 15.0,	CR= 0.003137	CX= -0.047322	CT= 0.198530
THETA= 20.0,	CR= 0.003753	CX= -0.059472	CT= 0.188857
THETA= 25.0,	CR= 0.004114	CX= -0.069183	CT= 0.177846
THETA= 30.0,	CR= 0.004251	CX= -0.076456	CT= 0.166173
THETA= 45.0,	CR= 0.003800	CX= -0.085865	CT= 0.132057
THETA= 90.0,	CR= 0.001472	CX= -0.063483	CT= 0.069084
THETA=135.0,	CR= 0.000477	CX= -0.030394	CT= 0.046776
THETA=180.0,	CR= -0.000000	CX= 0.000000	CT= 0.041258

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= -0.010429	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= 15.0,	CR= 0.001689	CX= -0.029812	CT= 0.169105
THETA= 20.0,	CR= 0.002095	CX= -0.038160	CT= 0.163824
THETA= 25.0,	CR= 0.002394	CX= -0.045343	CT= 0.157567
THETA= 30.0,	CR= 0.002588	CX= -0.051274	CT= 0.150632
THETA= 45.0,	CR= 0.002658	CX= -0.061766	CT= 0.128377
THETA= 90.0,	CR= 0.001371	CX= -0.052713	CT= 0.077528
THETA=135.0,	CR= 0.000497	CX= -0.026699	CT= 0.055538
THETA=180.0,	CR= -0.000000	CX= 0.000000	CT= 0.049699

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

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.0500

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 2.969055
THETA= 5.0,	CR= 0.084824	CX= -1.636172	CT= 1.169970
THETA= 10.0,	CR= 0.033696	CX= -0.931546	CT= 0.420964
THETA= 15.0,	CR= 0.021473	CX= -0.738763	CT= 0.137849
THETA= 20.0,	CR= 0.010166	CX= -0.526732	CT= 0.146795
THETA= 25.0,	CR= 0.005758	CX= -0.418102	CT= 0.033931
THETA= 30.0,	CR= 0.004995	CX= -0.370930	CT= 0.069642
THETA= 45.0,	CR= 0.000102	CX= -0.209380	CT= 0.027245
THETA= 90.0,	CR= -0.000298	CX= -0.086454	CT= 0.013395
THETA=135.0,	CR= -0.000156	CX= -0.035807	CT= 0.011073
THETA=180.0,	CR= 0.000000	CX= -0.000003	CT= 0.010583

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.1000

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 1.614891
THETA= 5.0,	CR= 0.063445	CX= -0.732622	CT= 1.117796
THETA= 10.0,	CR= 0.049584	CX= -0.733715	CT= 0.572688
THETA= 15.0,	CR= 0.031020	CX= -0.606414	CT= 0.311365
THETA= 20.0,	CR= 0.018204	CX= -0.486562	CT= 0.194245
THETA= 25.0,	CR= 0.011251	CX= -0.401701	CT= 0.124622
THETA= 30.0,	CR= 0.007364	CX= -0.339883	CT= 0.091874
THETA= 45.0,	CR= 0.002209	CX= -0.222454	CT= 0.041921
THETA= 90.0,	CR= 0.000230	CX= -0.093137	CT= 0.012682
THETA=135.0,	CR= 0.000041	CX= -0.038652	CT= 0.007675
THETA=180.0,	CR= 0.000000	CX= -0.000000	CT= 0.006633

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.1500

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 1.098105
THETA= 5.0,	CR= 0.041365	CX= -0.392300	CT= 0.910990
THETA= 10.0,	CR= 0.044744	CX= -0.513961	CT= 0.600408
THETA= 15.0,	CR= 0.033068	CX= -0.487498	CT= 0.381082
THETA= 20.0,	CR= 0.021973	CX= -0.425829	CT= 0.251447
THETA= 25.0,	CR= 0.014442	CX= -0.366896	CT= 0.174140
THETA= 30.0,	CR= 0.009650	CX= -0.317466	CT= 0.126980
THETA= 45.0,	CR= 0.003357	CX= -0.217080	CT= 0.060682
THETA= 90.0,	CR= 0.000432	CX= -0.092860	CT= 0.018169
THETA=135.0,	CR= 0.000102	CX= -0.038675	CT= 0.010695
THETA=180.0,	CR= 0.000000	CX= -0.000000	CT= 0.009139

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.2000

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 0.835097
THETA= 5.0,	CR= 0.027090	CX= -0.239559	CT= 0.746963
THETA= 10.0,	CR= 0.035136	CX= -0.362257	CT= 0.566372
THETA= 15.0,	CR= 0.030159	CX= -0.384810	CT= 0.402529
THETA= 15.0,	CR= 0.029953	CX= -0.384272	CT= 0.402383
THETA= 20.0,	CR= 0.022415	CX= -0.362700	CT= 0.286106
THETA= 25.0,	CR= 0.015724	CX= -0.327184	CT= 0.207362
THETA= 30.0,	CR= 0.010949	CX= -0.291472	CT= 0.156163
THETA= 45.0,	CR= 0.004178	CX= -0.208506	CT= 0.078203
THETA= 90.0,	CR= 0.000608	CX= -0.091895	CT= 0.023883
THETA=135.0,	CR= 0.000107	CX= -0.038313	CT= 0.014107
THETA=180.0,	CR= 0.000000	CX= 0.000000	CT= 0.012216

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.4000

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 0.434553
THETA= 5.0,	CR= 0.006553	CX= -0.066501	CT= 0.421419
THETA= 10.0,	CR= 0.011146	CX= -0.121654	CT= 0.386370
THETA= 15.0,	CR= 0.013082	CX= -0.159593	CT= 0.339323
THETA= 15.0,	CR= 0.013083	CX= -0.159593	CT= 0.339323
THETA= 20.0,	CR= 0.012895	CX= -0.180683	CT= 0.289944
THETA= 25.0,	CR= 0.011534	CX= -0.188698	CT= 0.244369
THETA= 30.0,	CR= 0.009770	CX= -0.187980	CT= 0.205197
THETA= 45.0,	CR= 0.005281	CX= -0.163339	CT= 0.125210
THETA= 90.0,	CR= 0.001000	CX= -0.084618	CT= 0.045457
THETA=135.0,	CR= 0.000263	CX= -0.036590	CT= 0.027734
THETA=180.0,	CR= 0.000000	CX= 0.000000	CT= 0.023878

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.6000

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 0.299028
THETA= 5.0,	CR= 0.002261	CX= -0.030022	CT= 0.294897
THETA= 10.0,	CR= 0.004164	CX= -0.057472	CT= 0.283180
THETA= 15.0,	CR= 0.005479	CX= -0.080429	CT= 0.265652
THETA= 15.0,	CR= 0.005479	CX= -0.080429	CT= 0.265652
THETA= 20.0,	CR= 0.006158	CX= -0.097959	CT= 0.244576
THETA= 25.0,	CR= 0.006298	CX= -0.110054	CT= 0.222095
THETA= 30.0,	CR= 0.006054	CX= -0.117328	CT= 0.199871
THETA= 45.0,	CR= 0.004422	CX= -0.119226	CT= 0.143091
THETA= 90.0,	CR= 0.001219	CX= -0.074577	CT= 0.062892
THETA=135.0,	CR= 0.000353	CX= -0.033815	CT= 0.040246
THETA=180.0,	CR= -0.000000	CX= 0.000000	CT= 0.035020

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.7999

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 0.231997
THETA= 5.0,	CR= 0.000994	CX= -0.016628	CT= 0.230214
THETA= 10.0,	CR= 0.001893	CX= -0.032391	CT= 0.225036
THETA= 15.0,	CR= 0.002623	CX= -0.046558	CT= 0.216941
THETA= 15.0,	CR= 0.002623	CX= -0.046558	CT= 0.216941
THETA= 20.0,	CR= 0.003145	CX= -0.058620	CT= 0.206609
THETA= 25.0,	CR= 0.003456	CX= -0.068328	CT= 0.194793
THETA= 30.0,	CR= 0.003579	CX= -0.075660	CT= 0.182207
THETA= 45.0,	CR= 0.003217	CX= -0.085385	CT= 0.145127
THETA= 90.0,	CR= 0.001252	CX= -0.063467	CT= 0.075956
THETA=135.0,	CR= 0.000405	CX= -0.030409	CT= 0.051377
THETA=180.0,	CR= -0.000000	CX= 0.000000	CT= 0.045300

RADIAL COORDINATE= 0.7749, AXIAL COORDINATE= 0.9999

THETA= 0.0,	CR= 0.000000	CX= 0.000000	CT= 0.192919
THETA= 5.0,	CR= 0.000514	CX= -0.010296	CT= 0.191999
THETA= 10.0,	CR= 0.000996	CX= -0.020228	CT= 0.189297
THETA= 15.0,	CR= 0.001418	CX= -0.029466	CT= 0.184980
THETA= 15.0,	CR= 0.001418	CX= -0.029466	CT= 0.184980
THETA= 20.0,	CR= 0.001760	CX= -0.037750	CT= 0.179298
THETA= 25.0,	CR= 0.002015	CX= -0.044901	CT= 0.172550
THETA= 30.0,	CR= 0.002181	CX= -0.050829	CT= 0.165053
THETA= 45.0,	CR= 0.002247	CX= -0.061415	CT= 0.140878
THETA= 90.0,	CR= 0.001165	CX= -0.052660	CT= 0.085175
THETA=135.0,	CR= 0.000423	CX= -0.026700	CT= 0.060986
THETA=180.0,	CR= -0.000000	CX= 0.000000	CT= 0.054561

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

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.0500

THETA	CR	CX	CT
0.0	0.000000	0.000000	3.129155
5.0	-0.000000	-1.617191	1.334933
10.0	-0.000000	-0.965258	0.479684
15.0	-0.000000	-0.749830	0.173032
20.0	-0.000000	-0.535840	0.157905
25.0	-0.000000	-0.424942	0.046988
30.0	-0.000000	-0.371601	0.073708
45.0	-0.000000	-0.213028	0.029014
90.0	0.000000	-0.087649	0.013273
135.0	-0.000000	-0.036261	0.010664
180.0	-0.000000	-0.000003	0.010107

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.1000

THETA	CR	CX	CT
0.0	0.000000	0.000000	1.711423
5.0	-0.000000	-0.703960	1.228441
10.0	-0.000000	-0.734054	0.651272
15.0	-0.000000	-0.611047	0.358060
20.0	-0.000000	-0.491799	0.220970
25.0	-0.000000	-0.405492	0.142764
30.0	-0.000000	-0.342132	0.103357
45.0	-0.000000	-0.223796	0.046827
90.0	0.000000	-0.093423	0.013891
135.0	-0.000000	-0.038747	0.008312
180.0	-0.000000	-0.000000	0.007150

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.1500

THETA	CR	CX	CT
0.0	0.000000	0.000000	1.175876
5.0	-0.000000	-0.374713	0.992736
10.0	-0.000000	-0.504963	0.671301
15.0	-0.000000	-0.486143	0.431400
20.0	-0.000000	-0.427300	0.285188
25.0	-0.000000	-0.368775	0.197303
30.0	-0.000000	-0.319094	0.143287
45.0	-0.000000	-0.217909	0.067926
90.0	0.000000	-0.092998	0.020153
135.0	-0.000000	-0.038712	0.011836
180.0	-0.000000	-0.000000	0.010105

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.2000

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.901263
5.0	-0.000000	-0.229245	0.813619
10.0	-0.000000	-0.353281	0.627463
15.0	-0.000000	-0.380744	0.451218
15.0	-0.000000	-0.380531	0.451158
20.0	-0.000000	-0.361620	0.322052
25.0	-0.000000	-0.327573	0.233896
30.0	-0.000000	-0.292333	0.175567
45.0	-0.000000	-0.209089	0.087333
90.0	0.000000	-0.091963	0.026558
135.0	-0.000000	-0.038384	0.015659
180.0	-0.000000	0.000000	0.013482

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.4000

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.476192
5.0	-0.000000	-0.064763	0.462433
10.0	-0.000000	-0.118994	0.425433
15.0	-0.000000	-0.156956	0.375142
15.0	-0.000000	-0.156954	0.375144
20.0	-0.000000	-0.178607	0.321656
25.0	-0.000000	-0.187293	0.271730
30.0	-0.000000	-0.187135	0.228463
45.0	-0.000000	-0.163285	0.139428
90.0	0.000000	-0.084689	0.050440
135.0	-0.000000	-0.036613	0.030735
180.0	0.000000	0.000000	0.026453

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.6000

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.329415
5.0	-0.000000	-0.029568	0.324976
10.0	-0.000000	-0.056679	0.312359
15.0	-0.000000	-0.079470	0.293405
15.0	-0.000000	-0.079470	0.293405
20.0	-0.000000	-0.096998	0.270500
25.0	-0.000000	-0.109200	0.245943
30.0	-0.000000	-0.116632	0.221553
45.0	-0.000000	-0.118961	0.158839
90.0	0.000000	-0.074602	0.069751
135.0	0.000000	-0.033831	0.044596
180.0	0.000000	0.000000	0.038796

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.7999

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.256135
5.0	-0.000000	-0.016470	0.254195
10.0	-0.000000	-0.032101	0.248560
15.0	-0.000000	-0.046176	0.239736
15.0	-0.000000	-0.046176	0.239736
20.0	-0.000000	-0.058193	0.228449
25.0	-0.000000	-0.067898	0.215511
30.0	-0.000000	-0.075258	0.201698
45.0	-0.000000	-0.085140	0.160838
90.0	0.000000	-0.063458	0.084200
135.0	0.000000	-0.030416	0.056923
180.0	0.000000	0.000000	0.050181

RADIAL COORDINATE= 0.7000, AXIAL COORDINATE= 0.9999

THETA	CR	CX	CT
0.0	0.000000	0.000000	0.213218
5.0	-0.000000	-0.010229	0.212211
10.0	-0.000000	-0.020101	0.209254
15.0	-0.000000	-0.029292	0.204525
15.0	-0.000000	-0.029292	0.204525
20.0	-0.000000	-0.037544	0.198295
25.0	-0.000000	-0.044679	0.190888
30.0	-0.000000	-0.050604	0.182648
45.0	-0.000000	-0.061237	0.156014
90.0	0.000000	-0.052632	0.094382
135.0	0.000000	-0.026700	0.067562
180.0	-0.000000	0.000000	0.060437

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

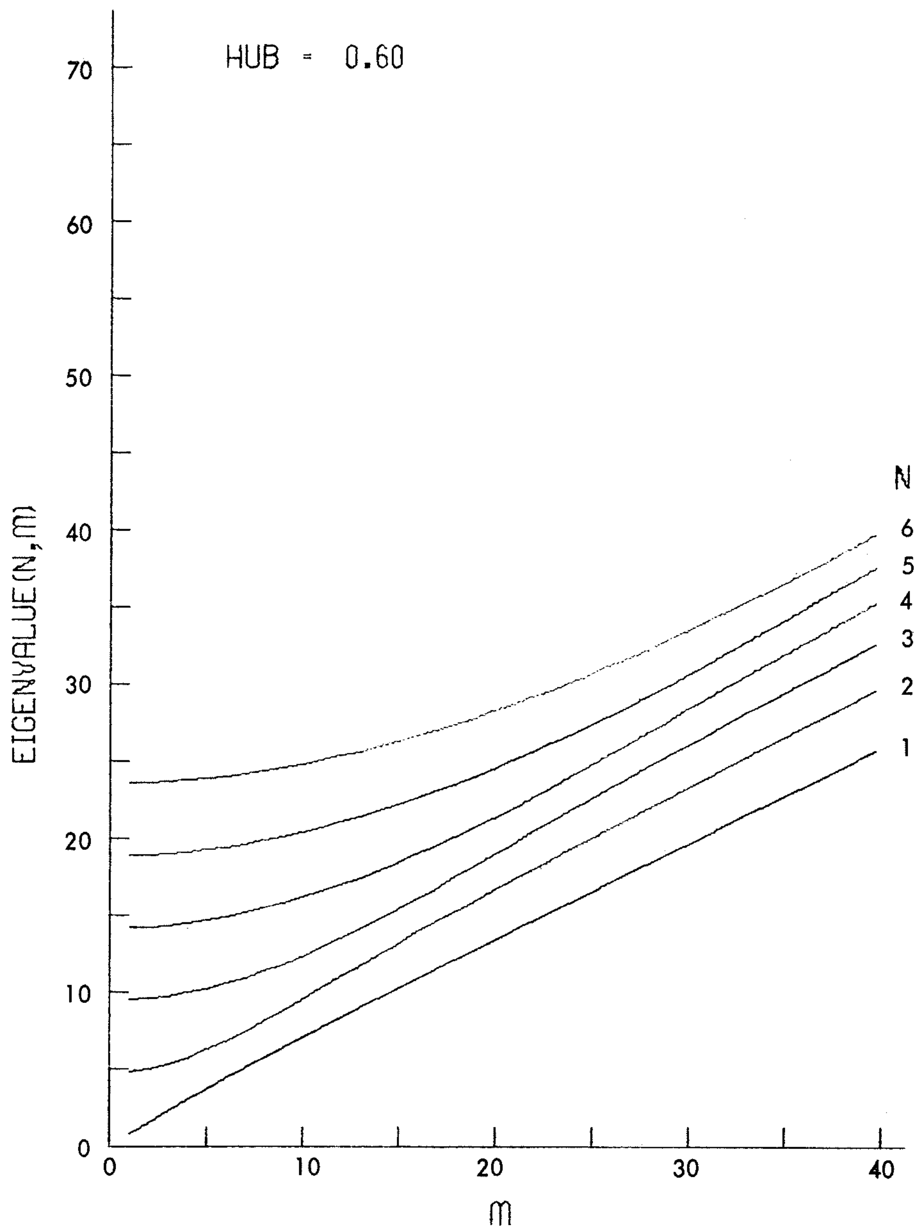

FIGURE 1 - EIGENVALUES FOR A 0.60 HUB RATIO

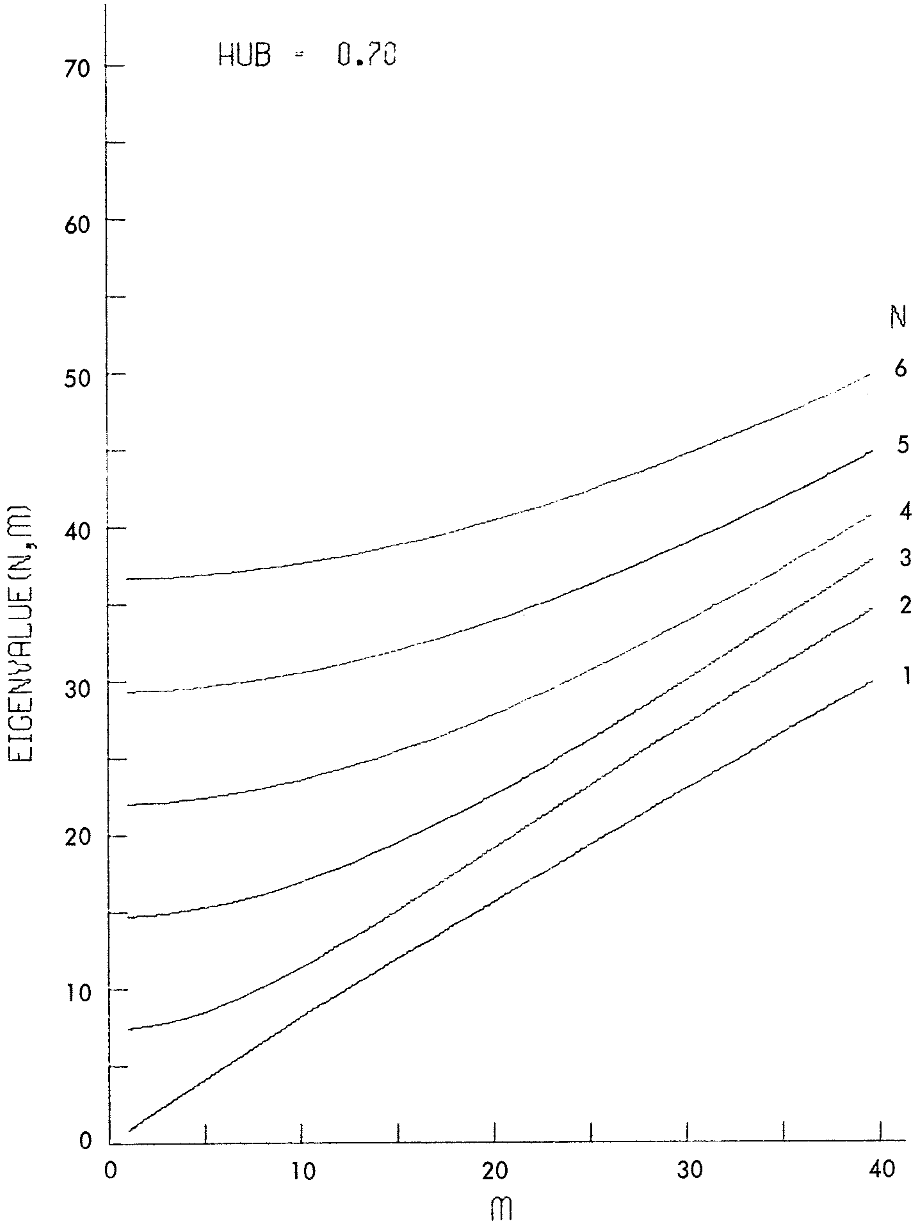

FIGURE 2 - EIGENVALUES FOR A 0.70 HUB RATIO

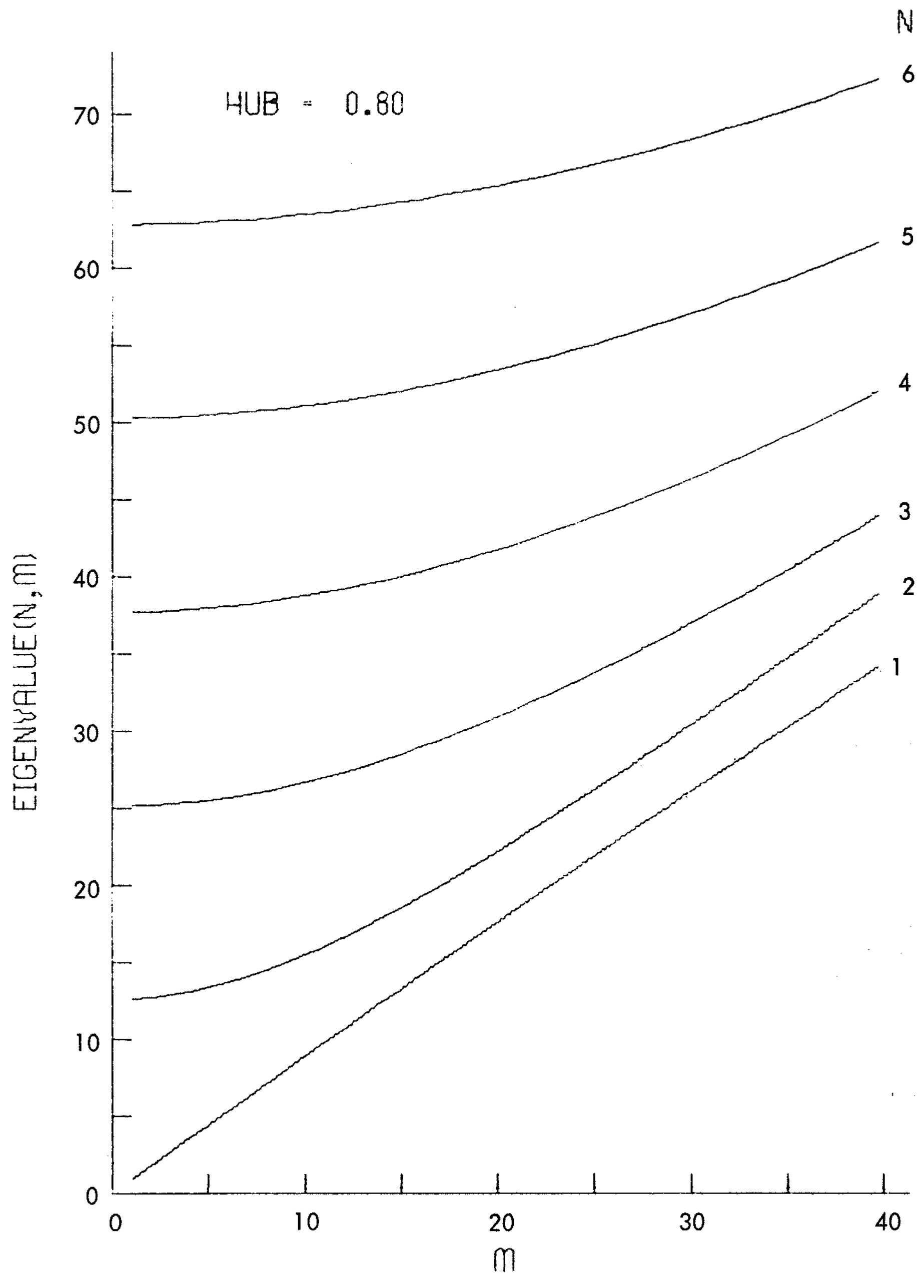

FIGURE 3 - EIGENVALUES FOR A 0.80 HUB RATIO

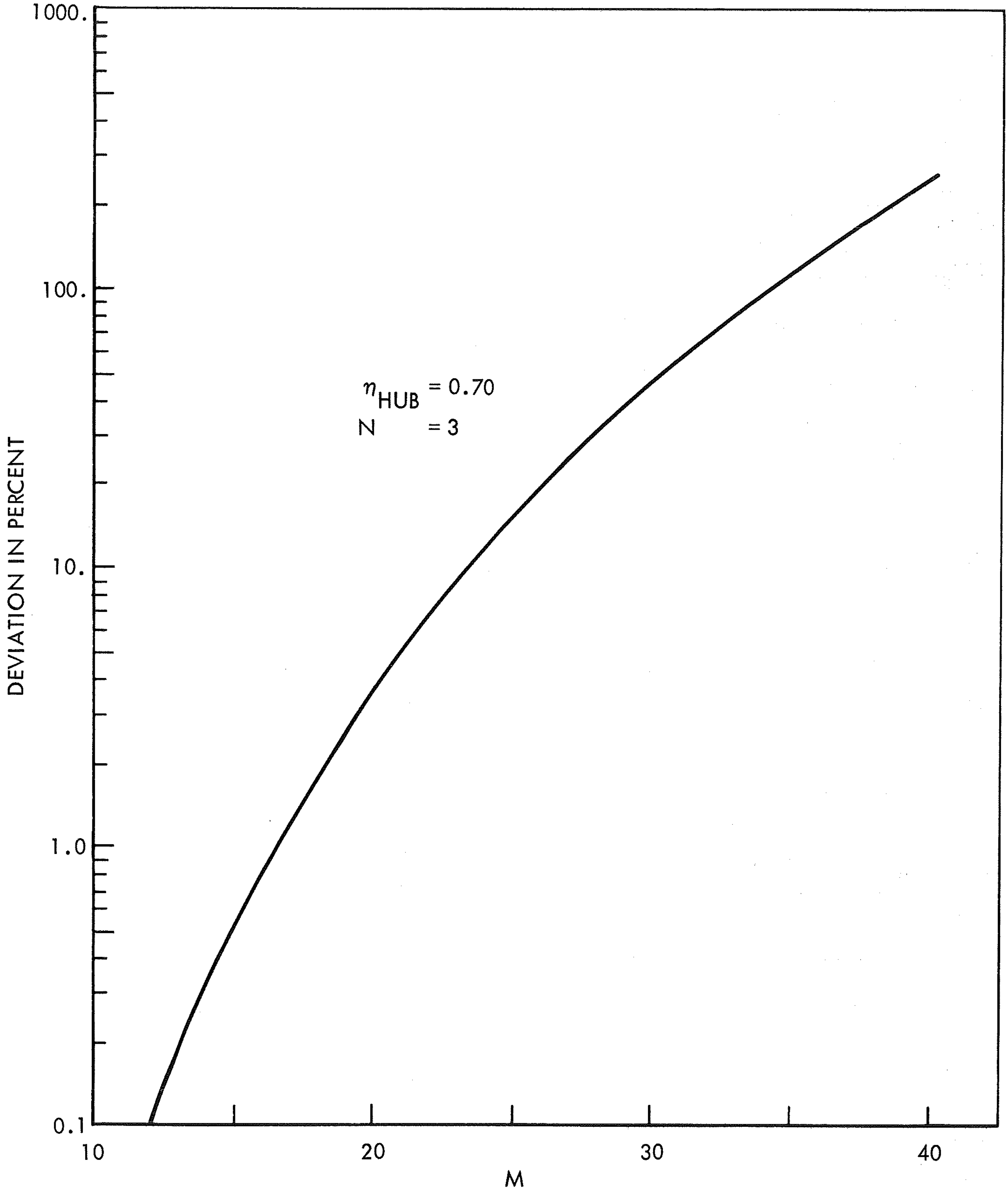

FIGURE 4 - DEVIATION IN PERCENT BETWEEN SERIES APPROXIMATION (REF. 2) TO EIGEN VALUES μ_{NM} AND NUMERICALLY CALCULATED VALUE

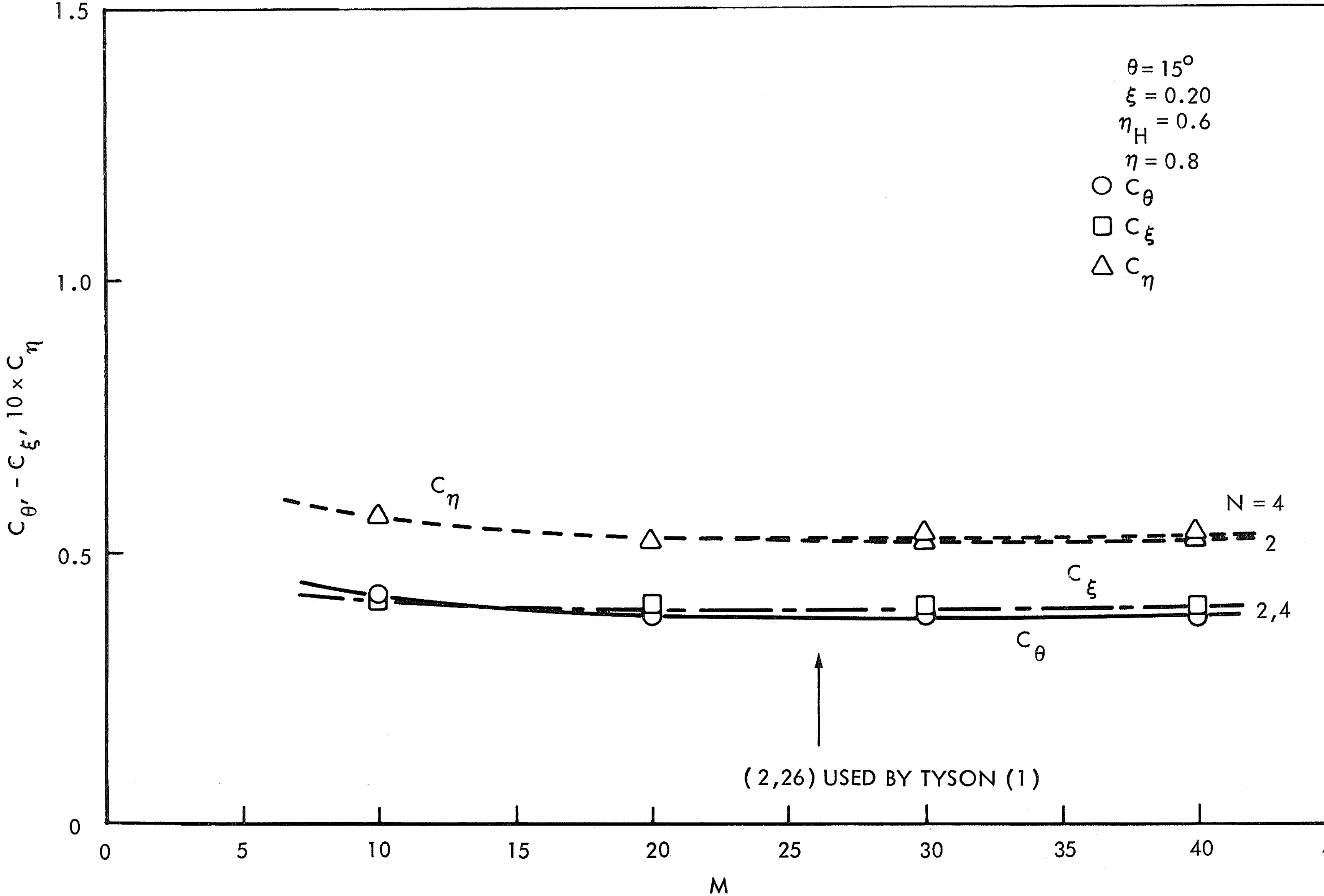

FIGURE 5 - CONVERGENCE OF C_θ, C_ξ, C_η WITH SERIES SIZE (N, M)

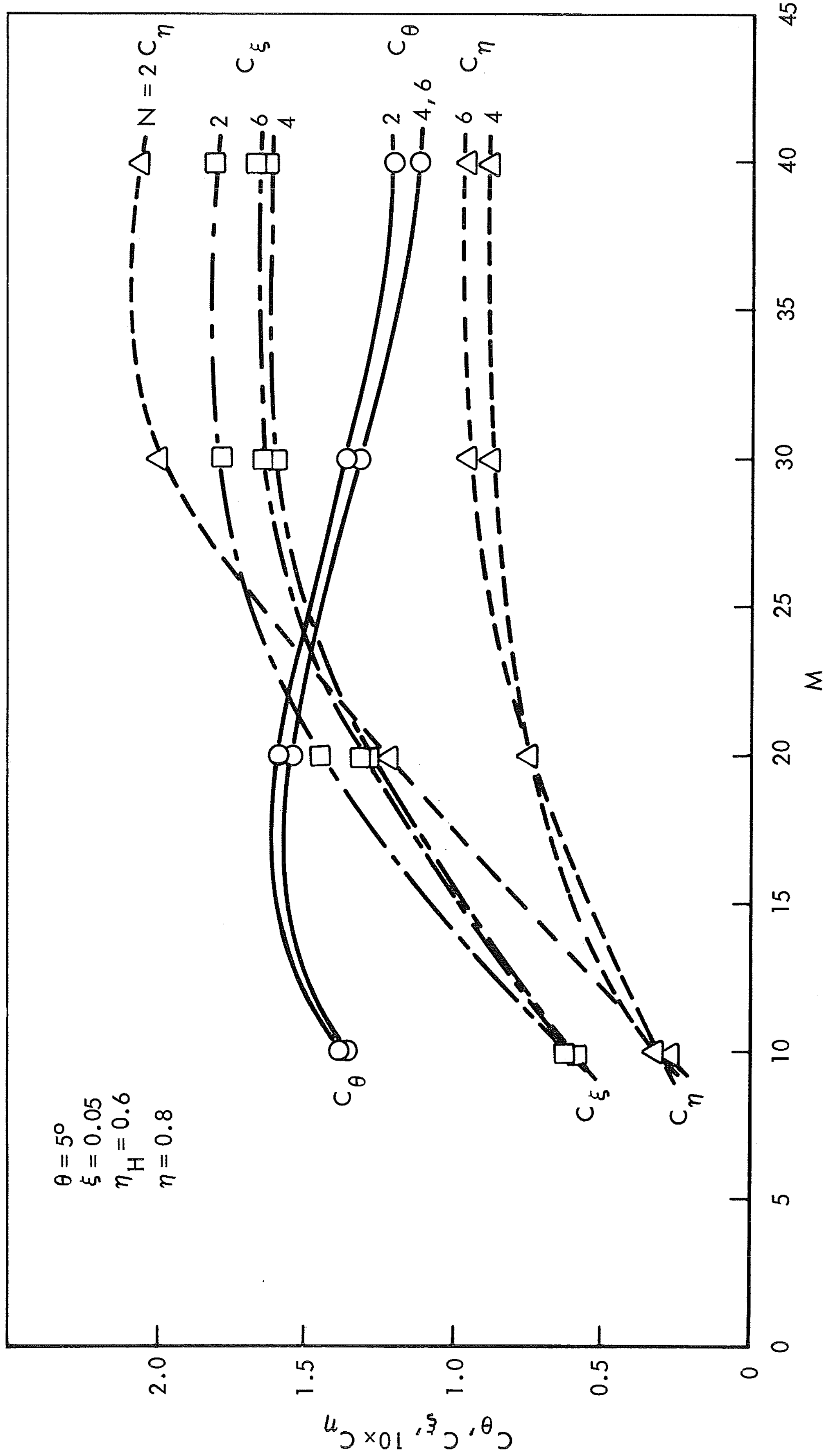

FIGURE 6 - CONVERGENCE OF C_θ, C_ξ AND C_η WITH SERIES SIZE (N, M)

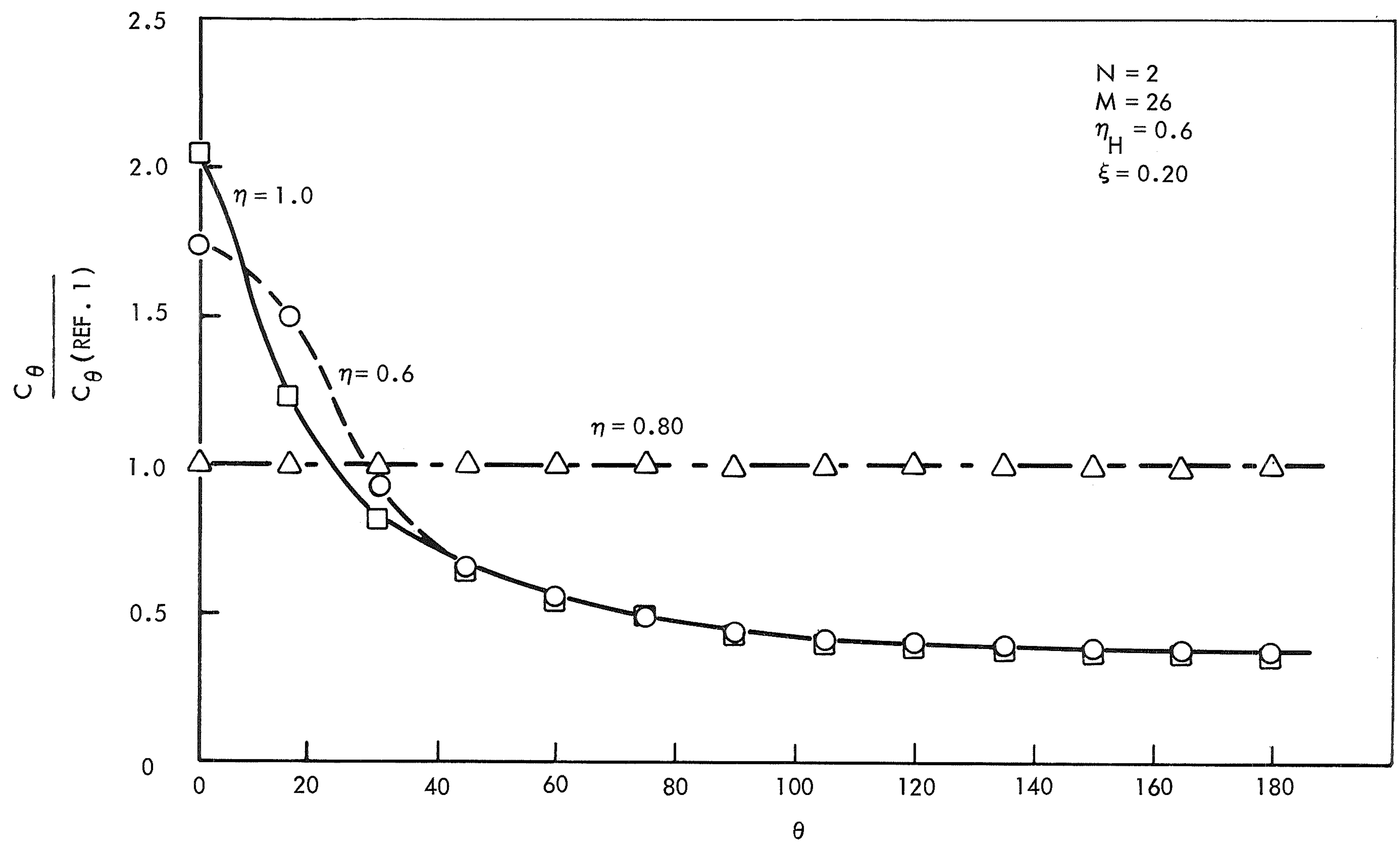

FIGURE 7 (A) - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY TO THE RESULTS OF REFERENCE (1), $N = 2$, $M = 26$, $\xi = 0.200$, $\eta_H = 0.600$

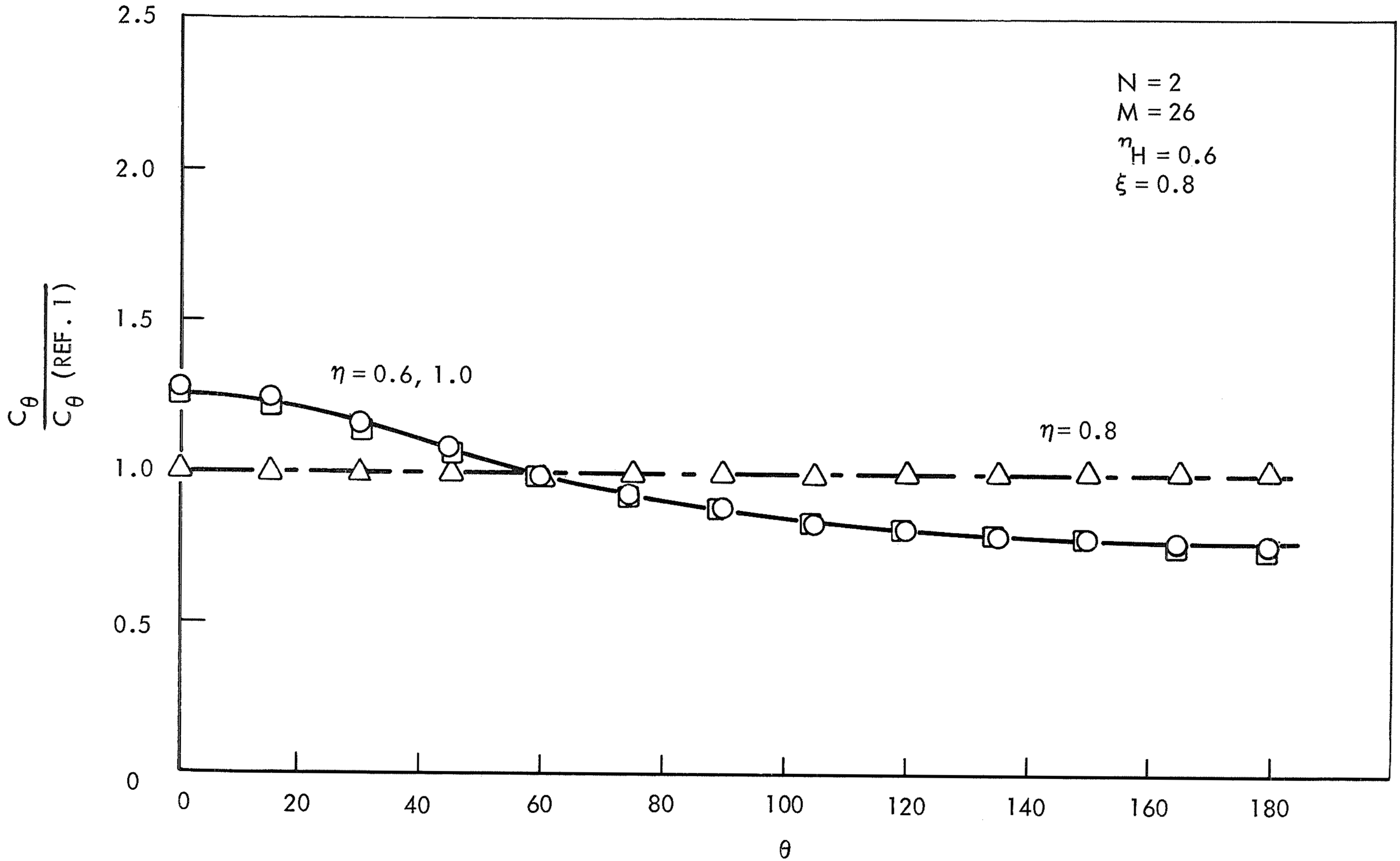

FIGURE 7 (B) - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY TO THE RESULTS OF REF. (1), N = 2, M = 26, $\xi = 0.800$, $\eta_H = 0.600$

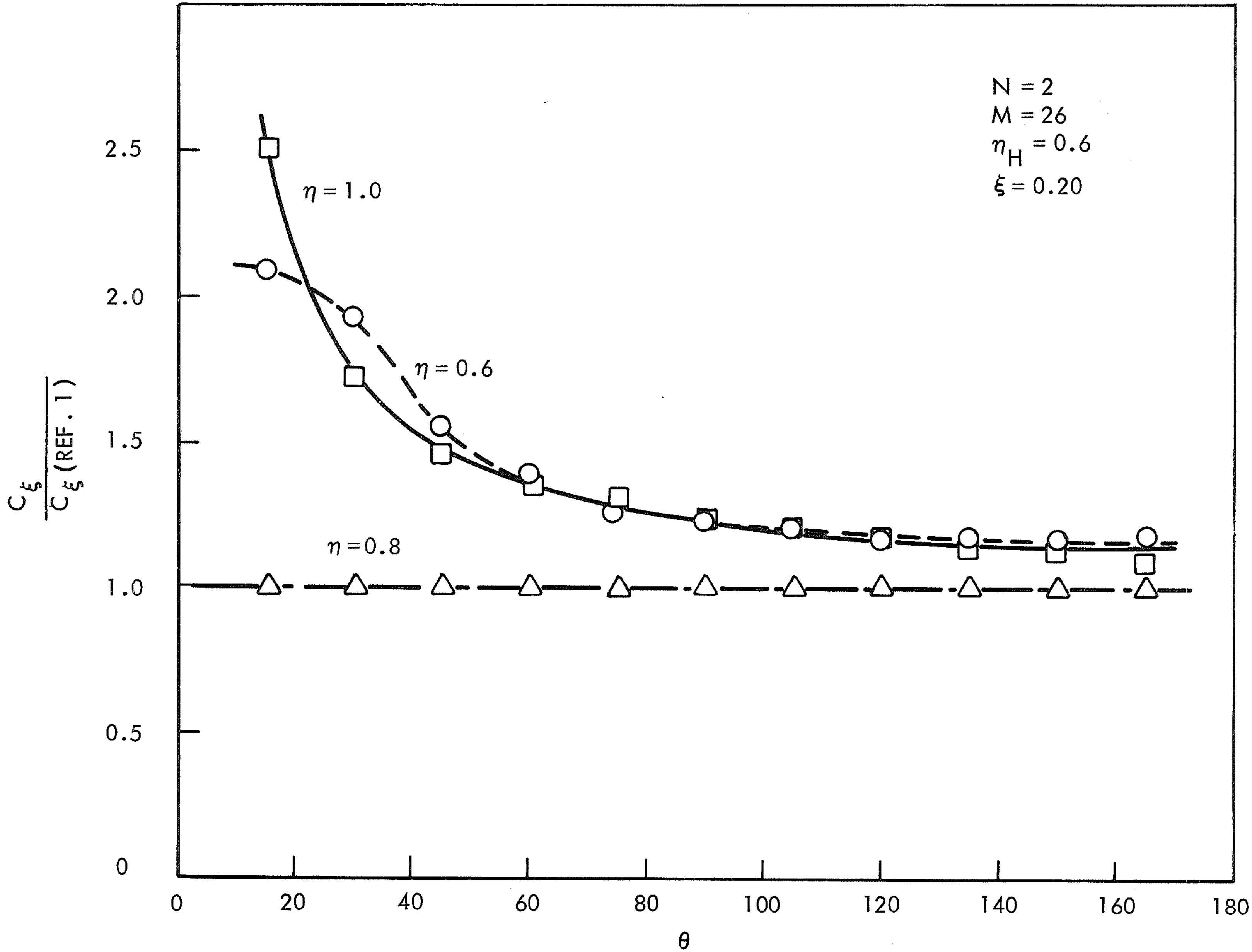

FIGURE 8 (A) - COMPARISON OF THREE-DIMENSIONAL AXIAL VELOCITY TO THE RESULTS OF REF. (1), N = 2, M = 26, $\xi = 0.200$, $\eta_H = 0.600$

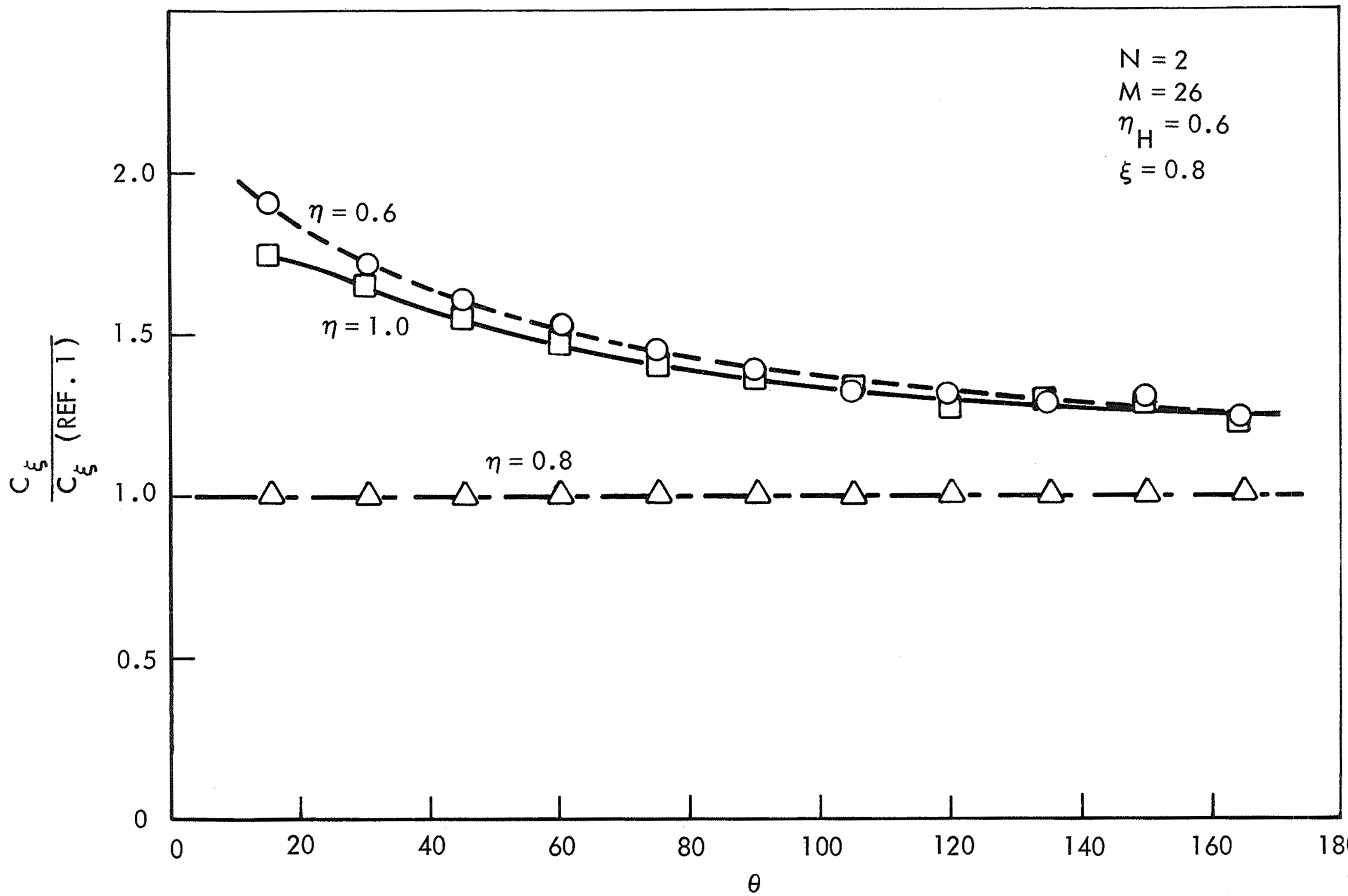

FIGURE 8 (B) - COMPARISON OF THREE-DIMENSIONAL AXIAL VELOCITY TO THE RESULTS OF REF. (1), N = 2 M = 26, $\xi = 0.800$, $\eta_H = 0.600$

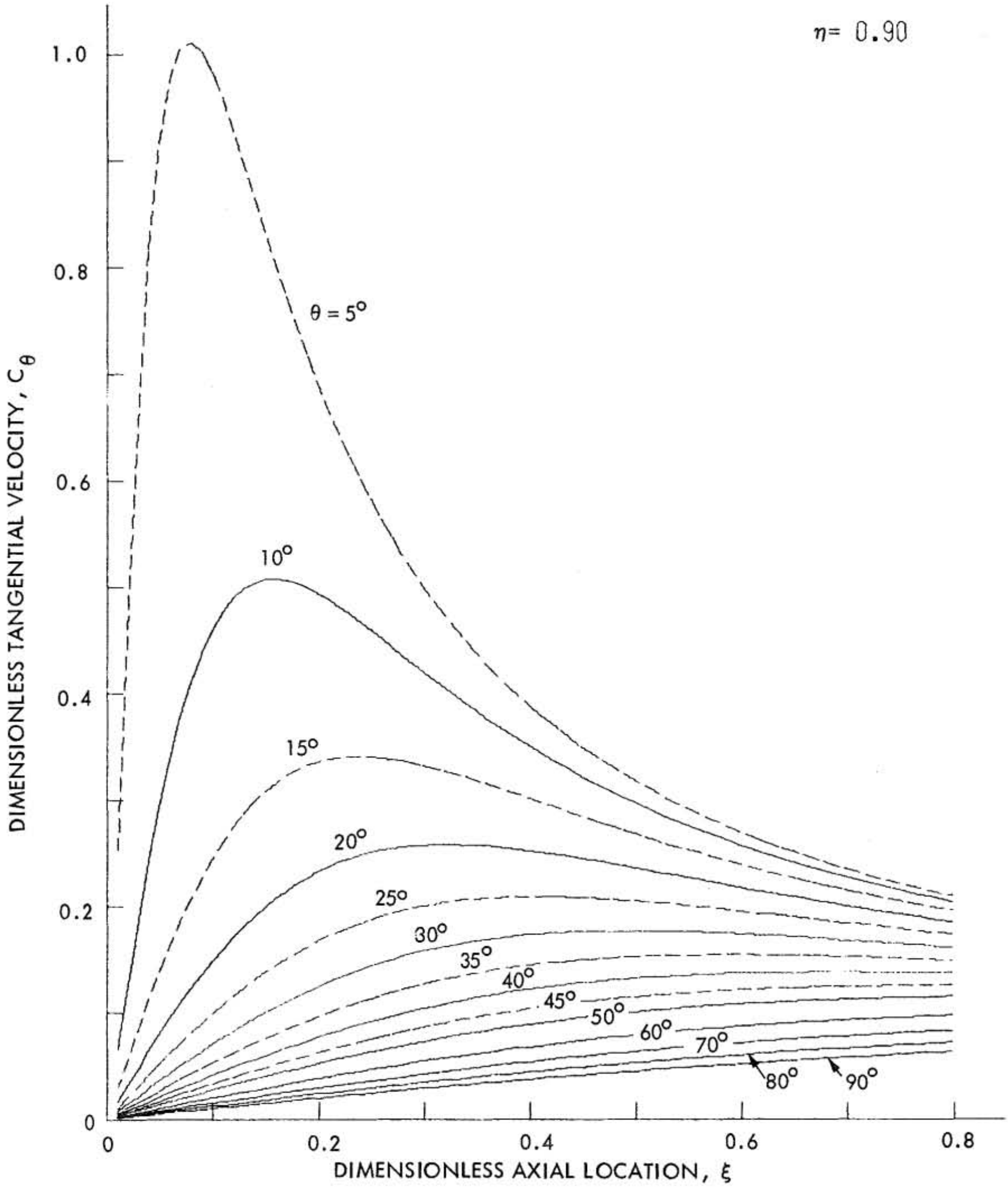

FIGURE 9 - TWO DIMENSIONAL SOLUTION OF TANGENTIAL VELOCITY FOR $\eta = 0.90$.

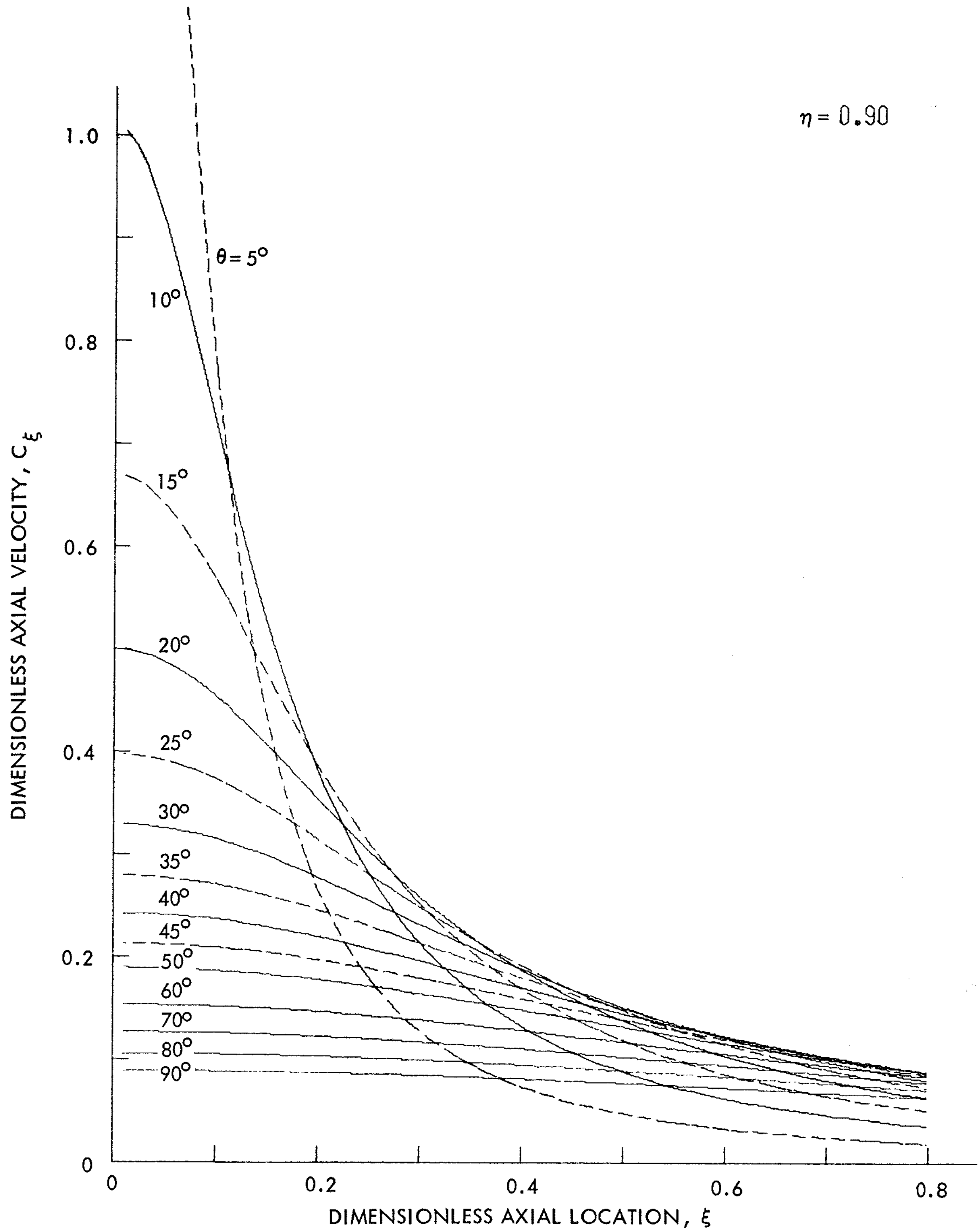

FIGURE 10 - TWO DIMENSIONAL SOLUTION OF AXIAL VELOCITY FOR $\eta = 0.90$

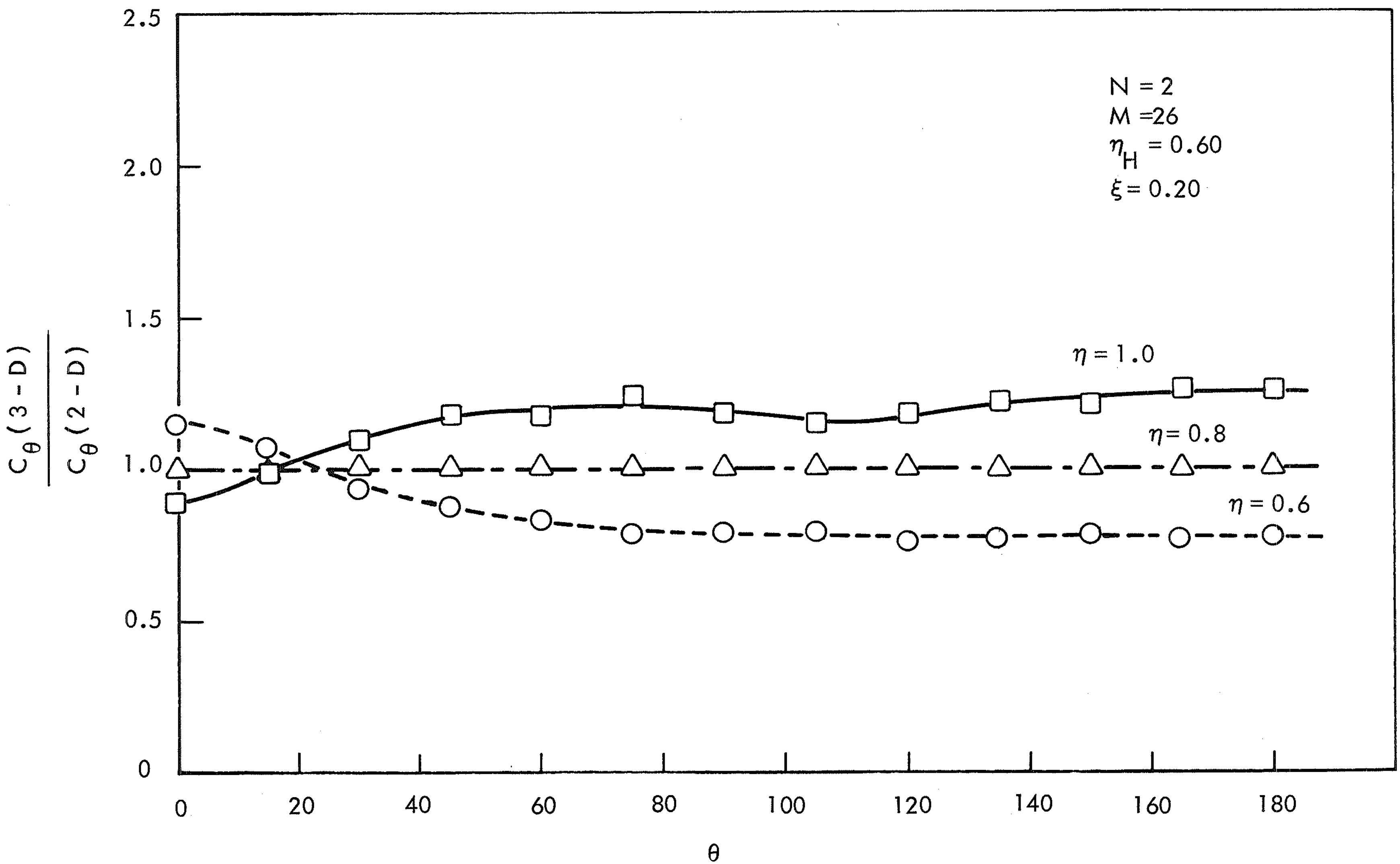

FIGURE 11 (A) - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY THE APPROXIMATE TO TWO- DIMENSIONAL SOLUTION N = 2, M = 26, $\xi = 0.200$, $\eta_H = 0.600$

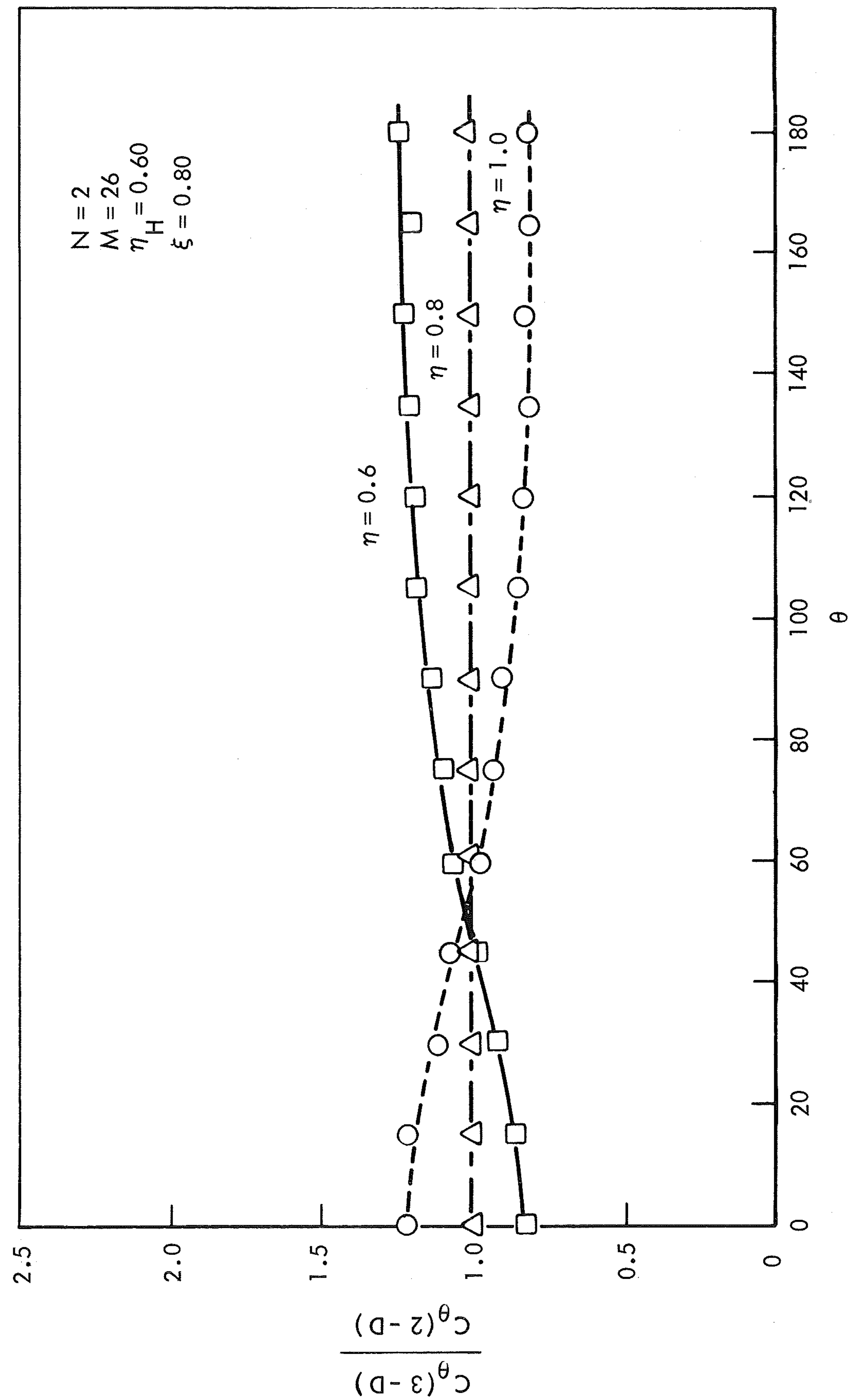

FIGURE 11 (B) - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY THE APPROXIMATE TWO-DIMENSIONAL SOLUTION $N = 2$, $M = 26$, $\xi = 0.800$, $\eta_H = 0.600$

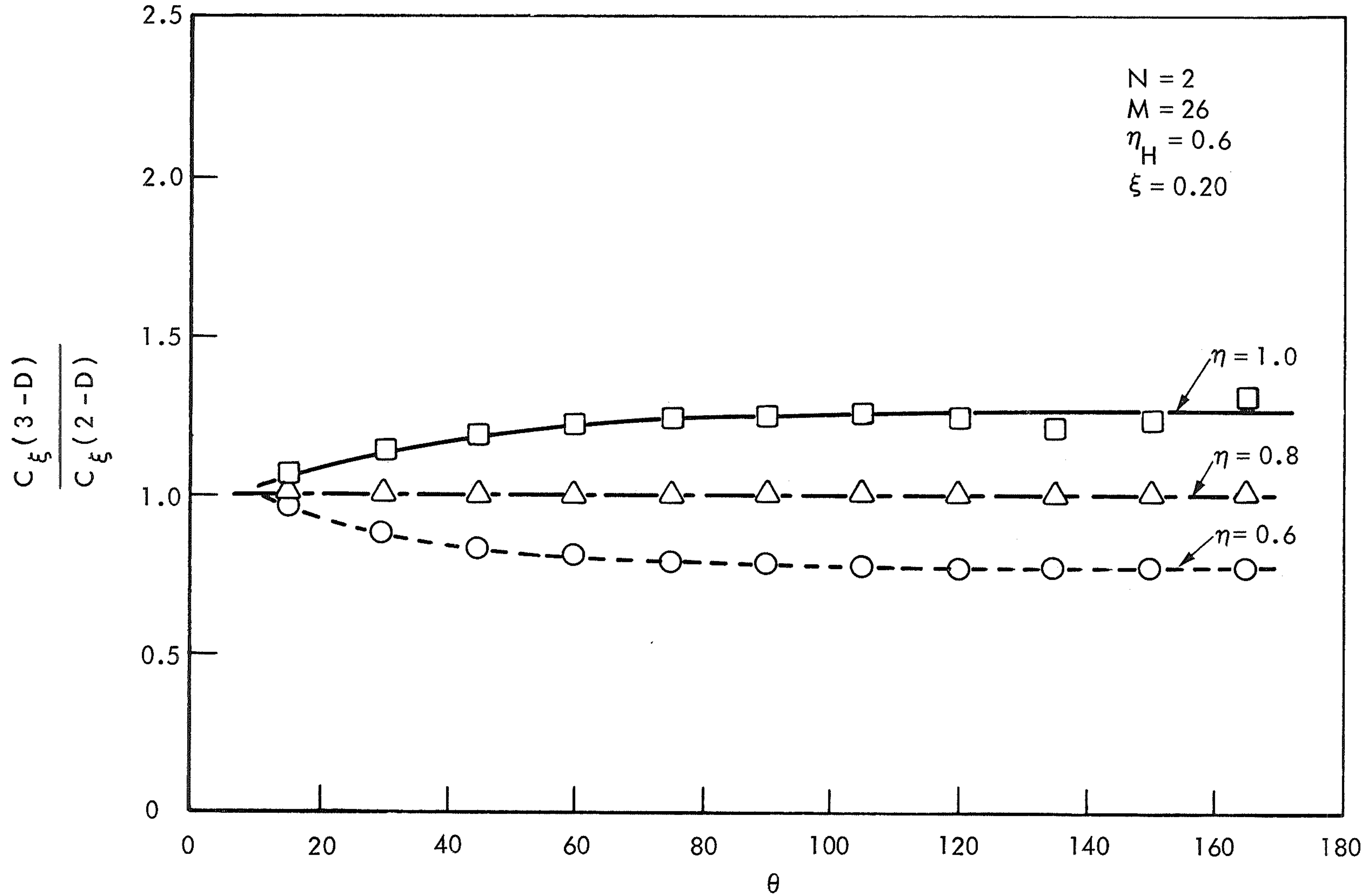

FIGURE 12 (A) - COMPARISON OF THREE-DIMENSIONAL AXIAL VELOCITY TO THE APPROXIMATE TWO-DIMENSIONAL SOLUTION N= 2, M = 26, $\xi = 0.200$, $\eta_H = 0.600$

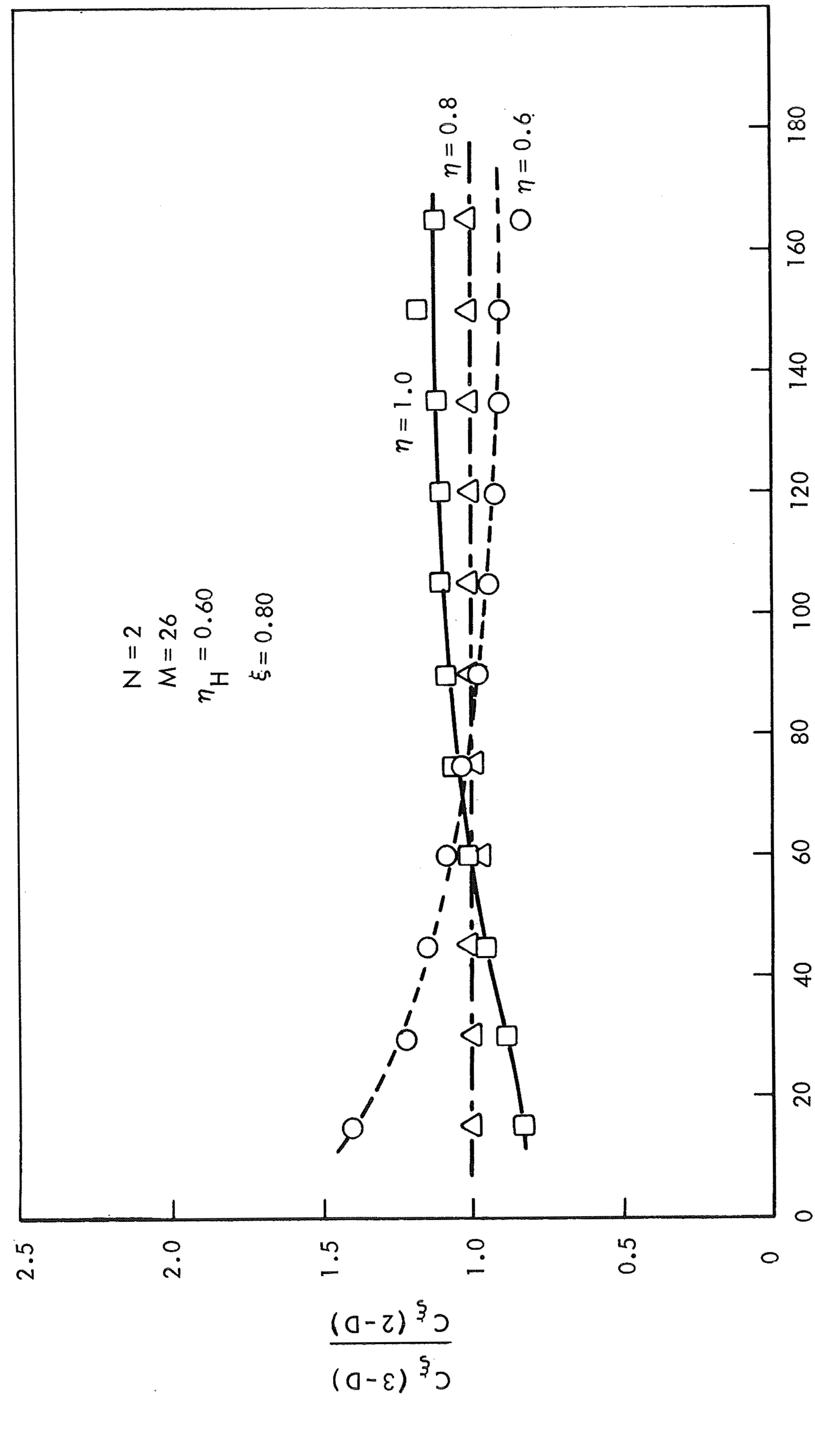

FIGURE 12 (B) - COMPARISON OF THREE DIMENSIONAL AXIAL VELOCITY TO THE APPROXIMATE TWO-DIMENSIONAL SOLUTION, N = 2, M = 26, $\xi = 0.800$, $\eta_H = 0.600$

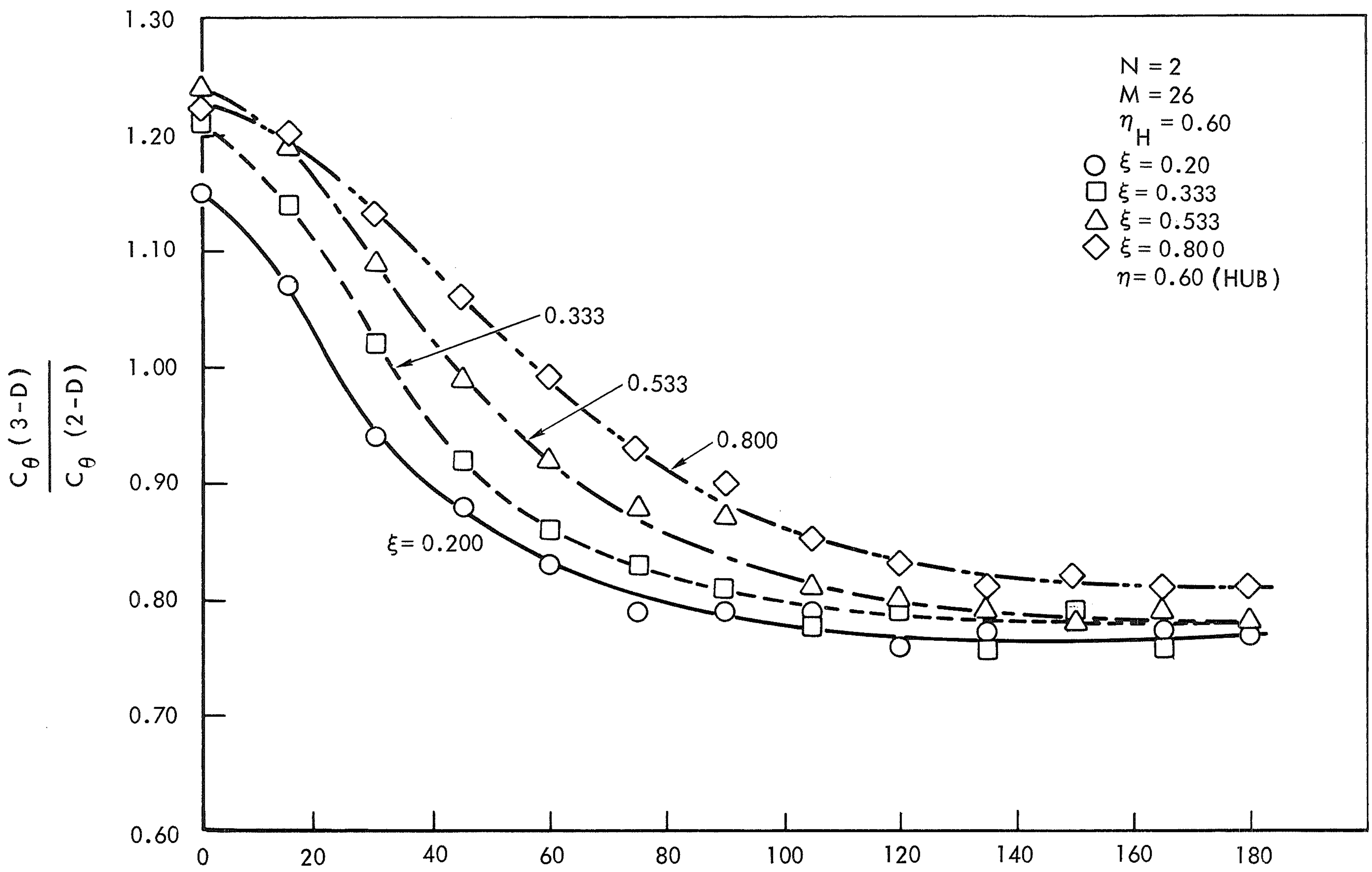

FIGURE 13 - COMPARISON OF THREE-DIMENSIONAL TANGENTIAL VELOCITY TO THE APPROXIMATE TWO-DIMENSIONAL SOLUTION AT THE HUB RADIUS FOR VARIOUS AXIAL LOCATIONS $\eta_H = 0.600$, N = 2, M = 26, $\xi = 0.200$ 0.333, 0.533, 0.800

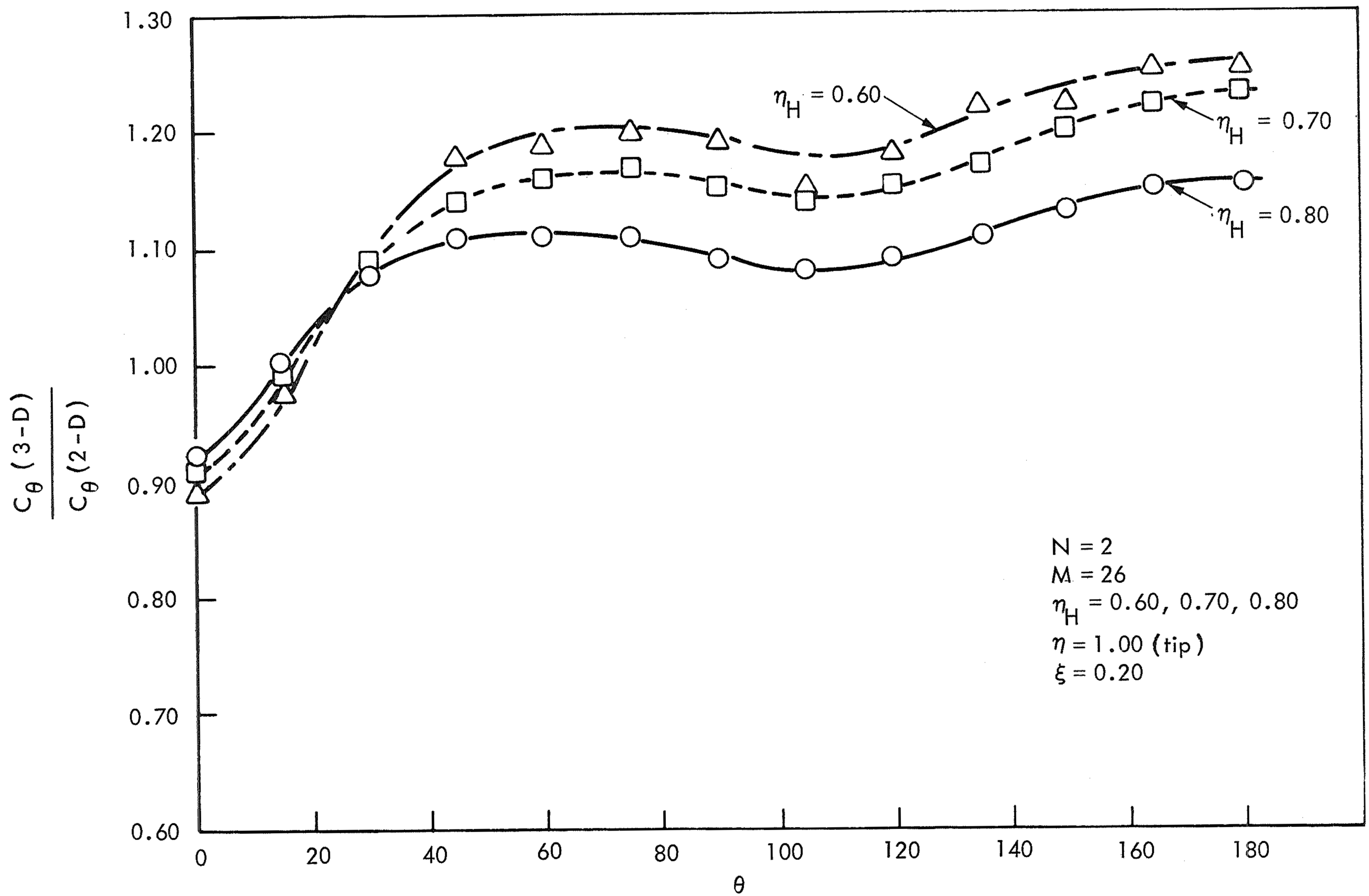

FIGURE 14 - INFLUENCE OF HUB RATIO ON THE RATIO OF THREE DIMENSIONAL TANGENTIAL VELOCITY TO THE APPROXIMATE TWO-DIMENSIONAL SOLUTION AT THE TIP RADIUS

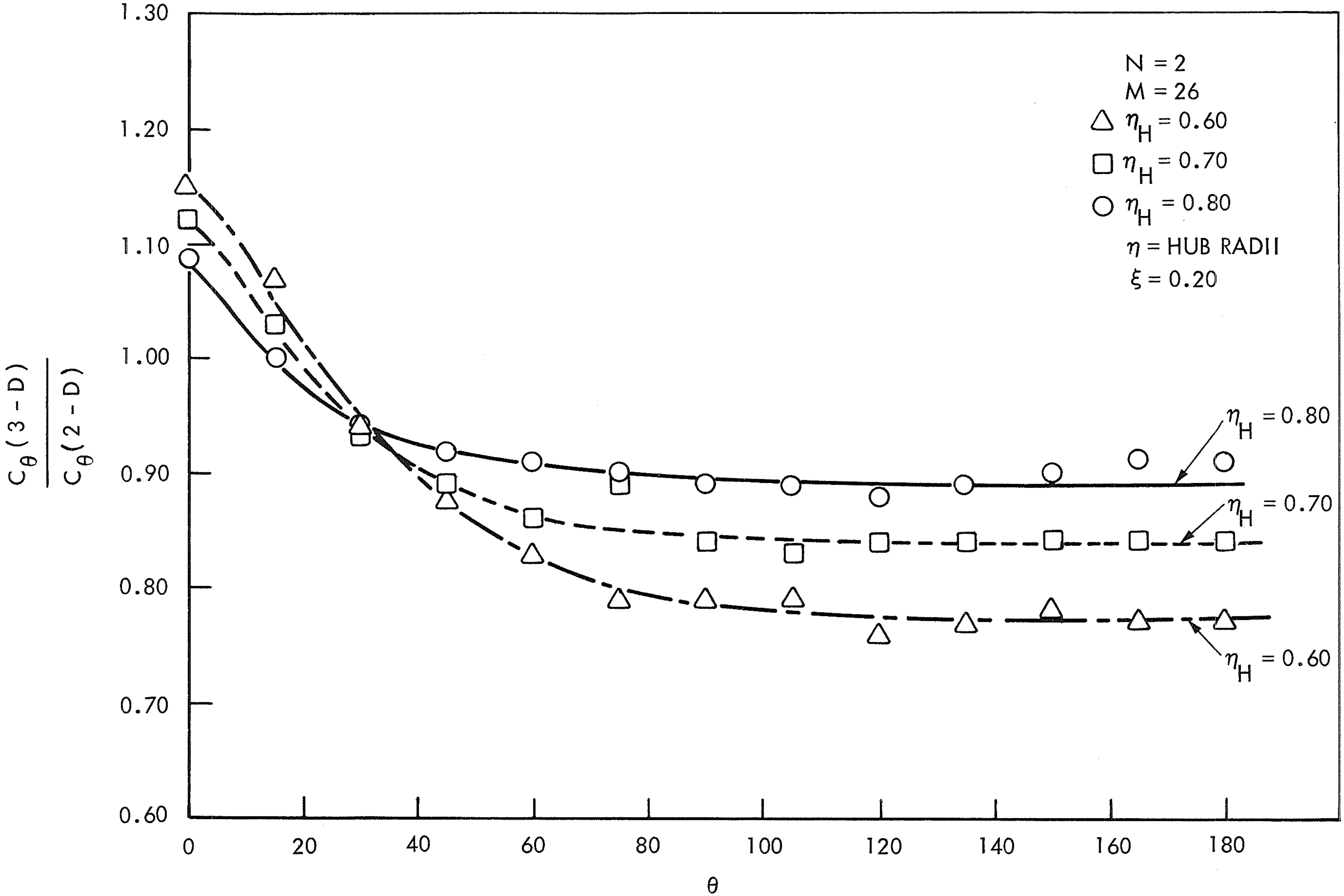

FIGURE 15 - THE INFLUENCE OF HUB RATIO ON THE RATIO OF THREE DIMENSIONAL TANGENTIAL VELOCITY TO THE APPROXIMATE TWO DIMENSIONAL SOLUTION AT THE HUB RADIUS

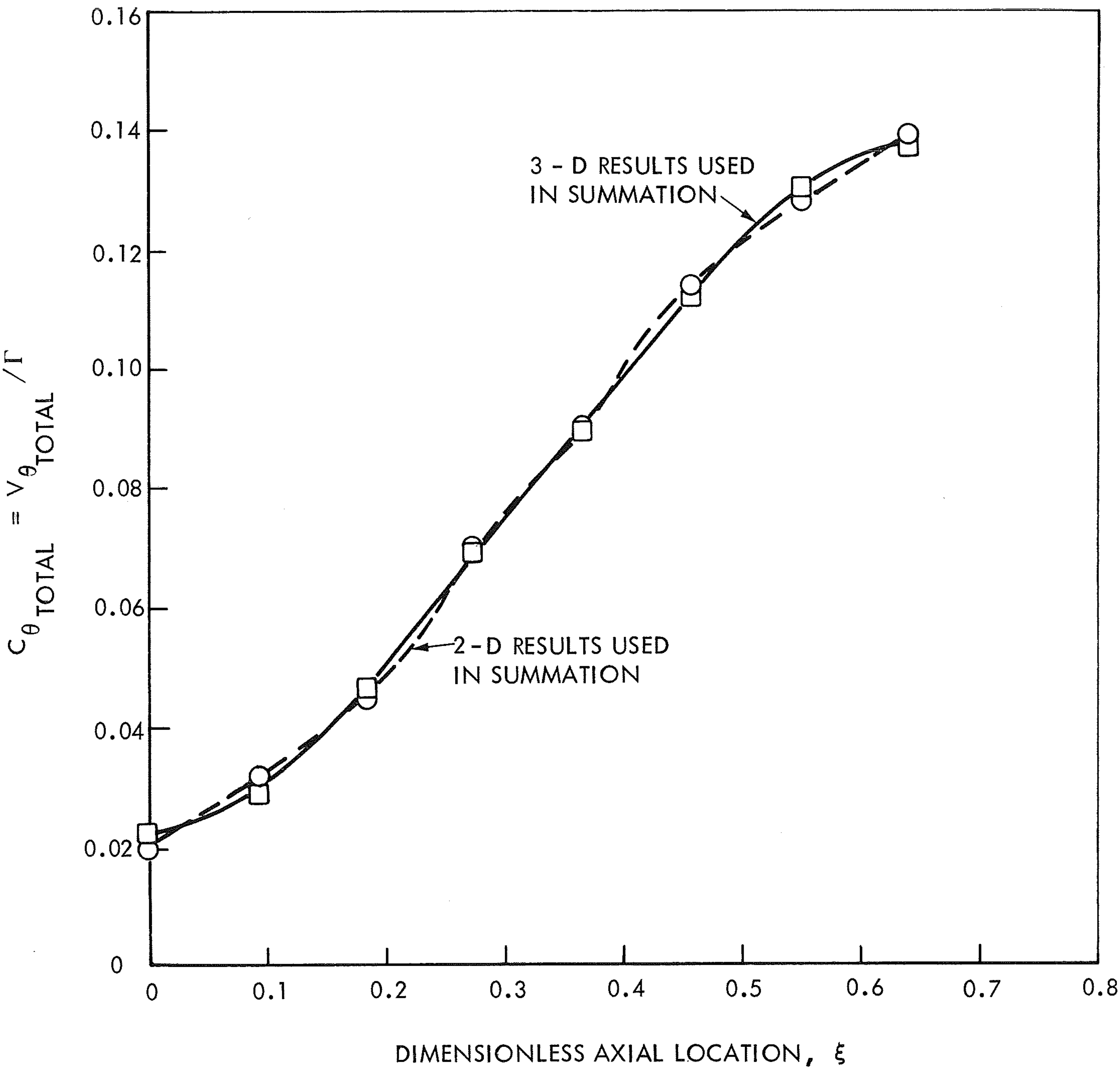

FIGURE 16 - SAMPLE INTERFERENCE STREAMLINE CALCULATION USING BOTH TWO AND THREE DIMENSIONAL RESULTS