NASA CONTRACTOR REPORT

NASA CR-2394

NASA CR-2394

ANALYSIS OF OSCILLATORY PRESSURE DATA INCLUDING DYNAMIC STALL EFFECTS

by Franklin O. Carta

Prepared by
UNITED AIRCRAFT RESEARCH LABORATORIES
East Hartford, Conn. 06108
for Langley Research Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • MAY 1974

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA CR-2394		

4. Title and Subtitle	5. Report Date
ANALYSIS OF OSCILLATORY PRESSURE DATA INCLUDING DYNAMIC STALL EFFECTS	May 1974
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Franklin O. Carta	
	10. Work Unit No.
9. Performing Organization Name and Address	
United Aircraft Research Laboratories 400 Main Street East Hartford, CT 06108	11. Contract or Grant No. NAS 1-11977
	13. Type of Report and Period Covered Contractor Report
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546	14. Sponsoring Agency Code

15. Supplementary Notes

The contract research effort which has lead to the results in this report was financially supported by USAAMRDL (Langley Directorate). This is a final report.

16. Abstract

The dynamic stall phenomenon was examined in detail by analyzing an existing set of unsteady pressure data obtained on an airfoil oscillating in pitch. Most of the data were for sinusoidal oscillations which penetrated the stall region in varying degrees, and here the effort was concentrated on the chordwise propagation of pressure waves associated with the dynamic stall. It was found that this phenomenon could be quantified in terms of a pressure wave velocity which is consistently much less than free-stream velocity, and which varies directly with frequency. It was also found that even when the stall region has been deeply penetrated and a substantial dynamic stall occurs during the downstroke, stall recovery near minimum incidence will occur, followed by a potential flow behavior up to stall inception.

A small portion of the original experiment was performed with ramp motions in which linear variations of incidence angle with respect to time produced large regions of constant angular velocity. Here it was found that both stall inception and stall recovery were dependent on the instantaneous value of angular velocity for high incidence angles, but showed some dependency on past history for low incidence angles.

A Fourier analysis was also performed on all data, and tabulations of pressure amplitude and phase angle harmonics are included.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Unsteady aerodynamics 2D oscillating airfoil	Unclassified - Unlimited Cat. 01

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	102	$4.50

*For sale by the National Technical Information Service, Springfield, Virginia 22151

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United Aircraft Research Laboratories

SUMMARY

The dynamic stall phenomenon was examined in detail by analyzing an existing set of unsteady pressure data obtained on an airfoil oscillating in pitch. Most of the data were for sinusoidal oscillations which penetrated the stall region in varying degrees, and here the effort was concentrated on the chordwise propagation of pressure waves associated with the dynamic stall. It was found that this phenomenon could be quantified in terms of a pressure wave velocity which is consistently much less than free-stream velocity, and which varies directly with frequency. It was also found that even when the stall region has been deeply penetrated and a substantial dynamic stall occurs during the downstroke, stall recovery near minimum incidence will occur, followed by a potential flow behavior up to stall inception.

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INTRODUCTION

It has been known for many years that a torsionally flexible airfoil at high angle of attack is susceptible to a self-induced, single-degree-of-freedom instability commonly referred to as stall flutter. As early as 1938, Bratt and Scruton (Ref. 1) were conducting tests to measure moment hysteresis in pitch and were using the concept of work per cycle around the moment loop to determine stability derivatives. Definitive and comprehensive studies were carried out later by Victory (Ref. 2) in Great Britain and by Halfman and his colleagues (Ref. 3) in this country. In these and in many other early experimental investigations the measurements were necessarily confined, by the limitations of instrumentation then available, to gross measurements of unsteady lift, moment, and aerodynamic damping ratio for harmonically oscillating airfoils, and to gross measurements of response amplitude for freely fluttering airfoils. Hence, for many years the problem of stability at high incidence could only be treated phenomenologically, and the details of the unsteady flow over the airfoil could not be determined.

In 1957 Rainey published a report (Ref. 4) which described, among other things, the use of miniature pressure transducers distributed chordwise over the airfoil to measure unsteady load distribution. Rainey's work is primarily concerned with the integrated unsteady forces and moments and his treatment of the unsteady pressure measurements is limited to a brief discussion in an Appendix. Similar dynamic stall experiments were performed in the late 1950's (Ref. 5) in which NACA differential pressure transducers distributed along the chord were used to measure the unsteady pressures on a two-dimensional NACA 0012 airfoil oscillating in pitch. These data were integrated to yield unsteady lift and pitching moment which, in turn, were applied to various analyses of helicopter rotor blade dynamic stability as described in Refs. 6 and 7. As in Ref. 4 the pressure data were primarily a means to obtain gross forces and moments, and only a cursory examination of unsteady chordwise loading was performed. A series of tests were then performed by Liiva et al (e.g., Refs. 8 and 9) in which unsteady pressures were again recorded and integrated to yield forces and moments. However, by this time the available recording and computing equipment had advanced to the point where it was feasible to also perform detailed analyses of the basic pressure data and, for example, plots of pressure time histories are found in Ref. 8 and tabulations of harmonic pressure amplitudes and phase angles are found in Ref. 9.

Within the past several years a serious effort has been made by many investigators to explain the dynamic stall phenomenon in more detail, both analytically and experimentally. Of particular interest in these studies has been the dynamic stall delay and the associated unsteady chordwise load distribution on an airfoil moving through the steady-state stall regime with positive angular velocity. In a recent theoretical study Ham (Ref. 10) was able to explain many of the features of stall delay and moment reversal on an oscillating airfoil operating above the stall angle by postulating a continuously shed vortex sheet from the airfoil leading edge. However, he was unable to derive a criterion for the delay between the time the steady-state stall angle is exceeded and the time the vortex sheet begins to be shed, nor was he able to predict reattachment of the separated flow (and hence closure of the moment loop) for decreasing angles of attack. In Ref. 11 Isogai indicated that the delay is associated with the formation and movement of an unsteady separation bubble. However, one remaining unknown in his investigation is the reason for the movement of the separation bubble against the adverse pressure gradient without bursting until well beyond the steady-state stall angle. These concepts are further discussed by McCroskey and Fisher in Ref. 12, who measured the chordwise motion of a shed vortex on a model rotor blade, and by Ham in Ref. 13, who speculates on bubble dynamics, bubble bursting, and dynamic stall as it relates to the adverse pressure gradient on a pitching airfoil.

In a related analytical investigation (Ref. 14) it is shown that the unsteady pressure gradient over the forward portion of an oscillating airfoil is less unfavorable than the steady pressure gradient, which can contribute to the delay in stall for a dynamic process. McCroskey, in Ref. 15, points out that the theory of Ref. 14 agrees well with his experimental measurements for laminar separation, but he also shows that the theory can only partially account for the dynamic stall delay. Thus, he concludes that although the inviscid theory of Ref. 14 accounts for the observed potential flow behavior of the oscillating airfoil, the viscous phenomenon of dynamic stall cannot be resolved by the same means.

Crimi and Reeves (Ref. 16) have made the first important attempt to solve this problem of dynamic stall using viscous equations along the airfoil in which an adequate definition of the boundary layer is obtained. Included in their analysis are the so-called strong interactions between the external or free-stream flow field and the flow through the separated region. This analysis predicts a dynamic stall overshoot in both lift and moment, and the resulting plots of these response functions versus incidence angle display the characteristic loop closure observed in the many experiments described earlier. However, these predicted results do not agree well with experimental data, as indicated in Ref. 15, largely because this first effort is limited by the assumptions and restrictions of the formulation, such as the use of linear airfoil theory to predict the inviscid pressure distribution, an empirical transition model based on an experimental Reynolds number correlation, and use of an integral technique to model the separation region. An improved analysis is currently being performed under Contract NAS1-11568 for the NASA Langley Research Center, which uses nonlinear unsteady aerodynamics, a finite difference viscous flow analysis in the separation region, and an analytical turbulence - kinetic energy approach to predict transition.

It is obvious from the foregoing paragraphs that, although a great deal of work has already been done, a significant amount still remains. Furthermore, as more detailed analytical studies are attempted there is an increasing need for comparably more detailed experimental results, particularly in the dynamic behavior of the chordwise load distribution. In a recent experimental program (Ref. 17) a substantial body of unsteady chordwise pressure data was recorded on FM magnetic tape. As in many other comparable experiments the emphasis in Ref. 17 was on the integration of data to yield unsteady lift and moment. In addition, the unsteady pressure data were carefully preserved and the detailed analysis of these data constitute the substance of this report. The original experiment was performed over a wide range of incidence angles, both above and below static stall, and for a number of oscillatory frequencies. Consequently, the character of the results obtained herein varies widely, from potential flow through a transition region up to a flow dominated by separation. Many of the results of this study can be explained and understood within the framework of the present state of the art; however, in view of the complexity of the dynamic stall phenomenon the interpretation of these results is necessarily incomplete, and it is hoped that additional studies may be performed in the future to answer these still outstanding questions.

SYMBOLS

A	angular velocity parameter, $c\alpha/2V$
A_o, A_n	harmonic pressure amplitudes
ΔCp	differential pressure coefficient
c	chord, meters
F, G	real and imaginary parts of Theodorsen circulation function
f, f_1	frequency, Hz
k	reduced frequency parameter, $c\omega/2V$
$\bar{k}_w$, k_{w_1}	average and initial wave number
n	harmonic index number
P, P_n	pressure phase angle, positive when pressure leads motion, deg
p_u, p_ℓ	upper and lower surface pressure, newtons/meter^2
T, T_1	period, sec
t	time, sec
Δt_1, Δt_2	time intervals, sec
t^*	dimensionless time, $\omega t/2\pi$
t_u, t_D	dimensionless upstroke and downstroke time for ramp cam motion
V	free-stream velocity, meters/sec
$\bar{V}_w$, V_{w_1}	normalized average and initial wave velocity
α	instantaneous angle of attack, deg
α_M	mean incidence angle, deg

$\bar{\alpha}$	angular amplitude, deg
$\bar{\nu}_w$, ν_{w_1}	average and initial reduced wave velocity
ρ	density, kilogram/meter^3
ϕ , ϕ_n	pressure phase angle, positive when pressure leads motion, radians
χ	dimensionless chord position
$\Delta\chi_1$	dimensionless chordwise interval
ω	frequency, radians/sec
$(\dot{\ })$	derivative with respect to time, sec^{-1}

TEST PROGRAM

The oscillating airfoil test program was performed for the U. S. Army in 1971 - 1972 under Contract DAAJ02-71-C-0003, and the details of the model, test facility, data system, and test procedure are fully documented in Ref. 17. Hence, the only aspects of the test program that will be discussed here are those that are germane to the analysis of the unsteady pressure data. In particular, Table II of Ref. 17 lists all the test conditions that were originally run, and the current study is confined to an analysis of Items 2, 7, and 8 from that table, which are reproduced here in somewhat greater detail in Table I. In the upper part of the table are the combinations of frequency and mean incidence angle at which test points were run for sinusoidal motion at an amplitude of $\bar{\alpha} = 8$ deg. The second-to-last column is the set of average frequencies generally used in this study, and the last column is the average reduced frequency, $k = c\omega/2V$, based on the average frequencies and on a blade chord of 0.127 m (5 in) and a free-stream velocity of 118.87 m/sec (390 ft/sec). The lower part of the table is for ramp motion, separated into forward and backward motions, denoted as such because the drive cam to produce the forward motion was reversed to produce the backward motion. This oscillatory schedule is completely documented in Ref. 17 and it is sufficient to note that over most of the motion the instantaneous angle of attack varied linearly with time (i.e., with constant angular velocity) over an incidence range of ± 8 deg relative to the mean angle. For the forward ramp the upstroke velocity was twice that of the downstroke and for the backward ramp the upstroke velocity was one-half that of the downstroke. Because this was a nonsinusoidal motion the frequencies listed here are the values of the fundamental (or one-per-rev) frequency of the drive cam. (Additional details of the ramp motions will be found in the last section of this report.)

Differential pressures were measured at ten chordwise locations, whose coordinates were chosen in accordance with a Gaussian integration procedure. In percent chord, these locations are 1.19, 6.15, 14.62, 25.83, 38.81, 52.38, 65.36, 76.57, 85.04, and 90.00. In the original test program these data were recorded on FM magnetic tape and were then digitized and stored on digital magnetic tape by means of the data system described in Ref. 17. These digitized pressure time histories were the subject of the present analysis, as described below.

DATA REDUCTION

Preliminary Data Preparation

As stated above, the unsteady pressure data for each chordwise location were digitized and stored on digital magnetic tape. The digital sampling rate was selected to yield a minimum of four samples/cycle in the tenth harmonic of the fundamental frequency and it can be seen in Table III of Ref. 17 that this minimum requirement was exceeded for most cases. This requirement of four or more samples/cycle in the tenth harmonic was specifically chosen to permit a valid ten-term Fourier analysis to be made without risk of higher harmonic distortion or encroachment into the lower harmonic data (e.g., aliasing in which the higher harmonics are folded into the low frequency domain; see Ref. 18).

Various aspects of the analysis were carried out on either the original time history or on an 8-cycle signal-averaged (or smoothed) time history (see Ref. 17 and pp. 116-118 of Ref. 19). In each case the procedure used will be identified. At small values of mean incidence angle both methods gave virtually identical results. At large values of mean incidence angle, when stalling was present, the signal-averaging procedure had the effect of reducing the influence of random noise and enhancing the coherent or repetitive parts of the signal. A comparison of the raw data with signal-averaged data is shown in Fig. 1 for the 1.19 percent chord location at a nominal frequency of 98.5 Hz for α_M = 12 deg and 16 deg. It is seen that although there are minor differences between these plots, the essential characteristics are retained in the smoothed plots. Further examples of the ability of the signal-averaged data to represent the raw data with satisfactory fidelity will be pointed out below.

Time History Displays

Time history displays were obtained by processing the raw time history data described above on a PDP-6 computer and displaying the results on a Tektronics Model 611 Storage Tube Oscilloscope (memo scope). These displays were then photographed for later analysis.

The data were arranged within the computer such that at each instant of time a continuous function was generated to provide a polynomial data fit through the ten chordwise locations. Interpolation of the chordwise distribution was then possible at equally spaced chordwise intervals between the dimensionless chord positions $x = 0.0119$ and $x = 0.90$ which were selected at the convenience of the investigator (usually 33 intervals were chosen but any integral number was possible). At each selected chordwise point a continuous time history was constructed with a sequence of straight lines between timewise points. Sufficient data were available to permit this type of fit and still yield a continuous behavior (from 40 to 100 points per cycle as can be determined from Table II of Ref. 17). A sample of this type of time history display is shown in the upper portion of Fig. 2 for α_M = 3 deg and f = 98.5 Hz . Here the pressure difference coefficient,

$$\Delta Cp(x,t) = - \frac{p_u(x,t) - p_\ell(x,t)}{\frac{1}{2}\rho V^2} \tag{1}$$

has been plotted versus time for a number of interpolated chordwise stations, as discussed above. The upper curve, labled $\alpha(t)$, is the time history of the angle of attack, and the horizontal line, labled datum, is the zero datum for the leading edge pressure wave. The upper curve (below the α trace) is the pressure at the 1.19 percent chord location (denoted L.E.), the bottom curve is the pressure at the 90 percent chord location (denoted T.E.) and all of the curves between these two are the intervening plots at 32 (in this case) equally spaced interpolated chordwise locations. To avoid confusion, datum lines for chordwise pressures other than the leading edge pressure are not included.

Because the vertical axis represents both pressure level and chordwise location the result is a pseudo-three-dimensional plot of the pressure time history surface from airfoil leading edge at the top to trailing edge at the bottom, with time increasing toward the right. The observer viewing this surface is positioned downstream of the trailing edge and above the zero pressure plane.

The lower portion of Fig. 2 is a contour plot in which constant pressure levels have been outlined. Again the chordwise extent of the display is from the 1.19 percent chord to the 90 percent chord. This contour plot (and others to be shown subsequently) is best interpreted by comparing it with the time history directly above it. (Note that in the contour plot the leading edge is at the bottom and the trailing edge is at the top.) The contour lines are crowded together in regions of large pressure gradient and are far apart in regions of small pressure gradient. Pressure levels are not explicitly included in the figures although the small superimposed numbers in the contour plots represent coded pressure levels, primarily intended for computer use.

Further clarification of this combination of time history pseudo-surface and contour plot is shown in Fig. 3 which is a schematic version of the plots in Fig. 2. For simplicity, only a few of the contour lines have been retained in the bottom half of the figure and they have been sketched into the time history surface in the top half of the figure. The appended numbers from 1 to 5 relate the contour lines in the upper and lower portions of the figure to one another. Also, the pressure time history surface at the top of the figure for the first cycle has been truncated along contour line number 1 to further relate the constant pressure surface in the upper portion of the figure with the constant level contour line in the lower portion.

In the course of this study it was found that the pressure time histories were useful in visualizing the phenomenon of dynamic stall and the interplay between potential flow and stalled flow. The contour plots were useful in quantifying certain aspects of the chordwise propagation of pressure waves. This will be described at length below. All the pressure time histories and timewise contour plots described herein are for raw data only.

Fourier Analysis

The pressure difference time histories were also analyzed harmonically to yield the average value and the first ten Fourier harmonics (amplitude and phase angle) at each chordwise transducer location. Specifically, it was assumed that for sinusoidal motions the unsteady angular displacement and pressure difference coefficient time histories could be represented by

$$\alpha(t) = \alpha_M + \bar{\alpha} e^{i\omega t} \tag{2}$$

$$\Delta Cp(x,t) = A_o(x) + \sum_{n=1}^{10} A_n(x) e^{i\left(n\omega t + \phi_n(x)\right)} \tag{3}$$

where x is a dimensionless chordwise coordinate normalized with respect to the airfoil chord, and where $\phi_n(x)$ is the phase angle in radians by which the nth harmonic leads the motion. For convenience a dimensionless time $t^* = \omega t/2\pi$ can be defined, and if $P_n(x) = 360\ \phi_n(x)/2\pi$ is the phase angle in degrees, the real parts of Eqs. (2) and (3) become

$$\alpha(t^*) = \alpha_M + \bar{\alpha} \cos 2\pi t^* \tag{4}$$

$$\Delta C_p(x,t^*) = A_o(x) + \sum_{n=1}^{10} A_n(x) \cos 2\pi \left(nt^* + \frac{P_n(x)}{360}\right) \tag{5}$$

Initially this ten-term harmonic analysis was performed on both raw data (one cycle) and on signal-averaged data for all frequencies at a mean angle of attack of $\alpha_M = 14$ deg. It was found that for the first four harmonics the differences between the raw and signal-averaged results were small, and either of the two could be used to represent the original function. (For the higher harmonics the amplitudes are so small as to be within the error band of the data and the phase angles tend to become meaningless.) A typical comparison between the two for $\alpha_M = 14$ deg and f = 50 Hz is shown in Figs. 4 and 5 for the amplitudes (note scale changes) and phase angles, respectively. At higher frequencies the two sets of data were virtually indistinguishable and at lower frequencies the agreement deteriorated only slightly. Therefore, because it was convenient to compute the harmonic coefficients for the time-averaged data, these have been used throughout the remainder of this study. Tabulations of all pressure harmonics will be found in Table II for the sinusoidal data and in Tables III and IV for the forward and backward ramp data, respectively.

ANALYSIS OF RESULTS

Potential Flow Behavior

The pressure time histories and timewise contour plots in Fig. 2 are typical of the potential flow behavior for low mean incidence angles and high frequencies. Here all the pressure waves are nearly sinusoidal, and it is seen that the trailing edge pressures lead the leading edge pressures. This is in agreement with potential flow theory. Specifically, the pressure phase angle, relative to the motion, can be derived from the formulas of Ref. 14 (with a suitable chordwise coordinate transformation and imposition of a quarter-chord pivot) as

$$\phi(x) = \tan^{-1}\left[\frac{kF + G - \frac{k}{2} + 4kx}{F - kG - 2k^2 x^2}\right] \tag{6}$$

A comparison between the theory as predicted by Eq. (6) and the measured first harmonic phase angle distribution for $\alpha_M = 3$ deg and f = 31, 75, and 98.5 Hz is shown in Fig. 6. The agreement is seen to be very good.

For future reference it is important to note the behavior of the timewise contour plot in the lower portion of Fig. 2. It was stated earlier that the contours are crowded together in regions of high pressure gradient. It can also be seen that zero pressure gradient will cause any given contour line to attain its chordwise extremum. From another point of view, if this were a topographical map of a ridge line (in this case a pressure ridge) with a monotonically decreasing altitude, the constant altitude contour lines would form a nested family of curves having its axis aligned with the ridge. This is indeed the case in Fig. 2 in which the family of contour lines is seen to be inclined from upper left to lower right, indicating a trailing edge lead and a leading edge lag.

Mixed Flow Behavior

As shown in Fig. 18 of Ref. 17, static stall for this test program began at approximately 12 deg incidence (as measured from the departure from linearity) and was complete at approximately 16 deg. In the dynamic portion of the test program the oscillatory amplitude was $\bar{\alpha} = 8$ deg. Hence the maximum incidence angle during each cycle of motion for $\alpha_M = 6$ deg was 14 deg, for 9 deg was 17 deg, etc. The unsteady results for $\alpha_M = 6$ deg were found to be nearly identical to those for $\alpha_M = 3$ deg, and thus were in good agreement with linear theory. This is not surprising because even at maximum incidence the static stall region has not been fully penetrated.

At α_M = 9 deg the beginnings of dynamic stall are evident near the end of the upstroke of the motion. This is seen in Fig. 7 in which memo scope photographs of pressure time histories and pressure contours for α_M = 9 deg and for f = 12.5, 31, and 98.5 Hz are reproduced. Before α reaches its maximum value the pressure time history attains a sharply peaked maximum value followed by a sudden drop in pressure. This sharp peak and sudden drop occurs first at the leading edge and propagates rearward along the chord, occurring at the trailing edge at some time later, and with less suddenness than at its inception at the leading edge. A deeper penetration into stall occurs at α_M = 11 deg, as seen in Fig. 8 for f = 12.5, 50, and 98.5 Hz. Here the sudden drop in pressure is more precipitous and a depressed pressure level extends over a greater portion of the cycle, compared with the results in Fig. 7 for α_M = 9 deg.

In both of these figures there is evidence that a potential flow exists over the portion of the cycle from minimum α to a point just before the pressure peak occurs. This is best seen in the two right hand panels of Figs. 7 and 8 for f = 98.5 Hz. When these figures are compared with Fig. 2 for α_M = 3 deg it is seen that all three manifest the same behavior during the upstroke; viz., a nearly sinusoidal wave first appears at the trailing edge which appears to propagate toward the leading edge. An examination of the contour plots in all three figures (for f = 98.5 Hz) also shows a characteristic nesting of the family of curves with an axis that is inclined from upper left to lower right. Note, however, that the contour plots for α_M = 11 deg, f = 98.5 Hz in Fig. 8 exhibit a second set of extrema which are inclined from upper right to lower left, indicating a rearward propagation of pressure waves, in this case associated with dynamic stall.

This mixed flow condition, consisting of potential flow during the upstroke and stall flow during the downstroke, is to be expected when the mean angle of attack is at or near the stall angle (such that excursions take place into both potential flow and stall flow). However, it is surprising to note the persistence of this mixed flow at mean angles of attack up to α_M = 16 deg, as shown in Fig. 9 for f = 98.5 Hz. This condition appears to be frequency dependent and becomes much less pronounced at lower frequencies, but at high frequency the potential flow region can be observed in Fig. 9 as a sinusoidal wave in the upstroke portion of the time history, progressing from trailing edge to leading edge. It also appears in the portion of the nested family in the contour plots whose axis is inclined from upper left to lower right. Note that the contour plots in Fig. 9 show a diminishing potential behavior relative to the stall wave propagation as the mean angle of attack increases. Specifically, a prominent lobe to the left of the peak incidence angle which is associated with potential flow at α_M = 12 deg is diminished at 14 deg and virtually disappears at 16 deg.

Stall Flow Behavior

A series of memo scope photographs are presented in Figs. 10, 11, and 12 to illustrate the effects of both frequency (over the entire range from 12.5 to 98.5 Hz) and mean angle of attack (α_M = 12, 14, and 18 deg, respectively) on the pressure response during dynamic stall. In Fig. 10 for α_M = 12 deg the effect of increasing frequency appears to lessen the severity of the stall. At f = 12.5 Hz a sudden stall occurs during the upstroke followed by recovery during the downstroke. In all succeeding parts of Fig. 10 recovery seems to be initiated at roughly the same part of the downstroke but the depth of the stall drop-off is diminished markedly as frequency increases. Similar behavior is observed in Fig. 11 for α_M = 14 deg, but a higher frequency is needed before dynamic stall drop-off is reduced appreciably. This is seen by comparing the panels for f = 50 Hz in both figures. Although there is some effect of frequency at α_M = 18 deg (Fig. 12) its influence is considerably less than at lower mean incidence angles, and the deep penetration into stall causes the same type of dynamic stall drop-off over the entire frequency range. A comparison of the right hand panel of Fig. 9 for α_M = 16 deg at f = 98.5 Hz shows a behavior more like α_M = 14 deg than like α_M = 18 deg.

A recent paper by Martin and his co-workers (Ref. 20) is concerned with the dynamic stall phenomenon, and discusses, among other things, the rearward propagation of the dynamic stall cell along the chord of the oscillating airfoil. The description of Fig. 2 in Ref. 20 states that "the peaking of the leading edge pressure indicates that stall has begun". It is further indicated that the disturbance appears to progress toward the trailing edge, indicative of the passage of a vortex over the airfoil, and the appearance of another pressure disturbance is indicative of the formation of a secondary vortex.

Multiple pressure waves are also observed in the present study, as seen in selected panels of Figs. 7 through 12. Here both secondary and tertiary pressure waves propagate rearward in the vicinity of the airfoil leading edge, although they appear either to merge with the primary wave or to attenuate to an undetectible size. It appears that in some instances (e.g., f = 50, 75, 98.5 Hz at α_M = 14 deg in Fig. 11), when a strong secondary wave is generated, the primary wave is retarded sufficiently (perhaps by some mutual interaction) to cause the two waves to coalesce, after which the rearward propagation of a single strong wave is observed. This observation will be of some value below in explaining the possible reasons for the appearance of a "kink" in the pressure ridge locus.

Wave Velocity Calculations from Chordwise Time Delay

Measurements were made of the propagation rate of the pressure wave along the chord using the contour plots prepared from the memo scope photographs. Figure 13 depicts this schematically. The upper portion of the figure is an idealized sketch of the pressure time history showing chordwise propagation of a wave. (Note that in this sketch the leading and trailing edge positions are opposite to those of the memo scope time histories, but are in conformity with the contour plots.) An event begins at the leading edge at t_0 and reaches a chordwise station x after some interval $\Delta t(x)$. The event repeats itself after one period, T, has elapsed.

It was stated earlier that the constant altitude contour lines would form a nested family of curves, and this has been shown in previous figures. The locus of the extrema of these contour lines will represent the direction of the ridge line on the x, t plane, and hence can be used to calculate the propagation rate. The lower portion of Fig. 13 shows a two-segment representation of the locus of ridge line extremeties as it would be superimposed on one of the earlier contour plots. The point 0 is the extension of the locus to the leading edge and the point 2 is the extension to the trailing edge (recall that the memo scope photos cover the range $0.0119 \leq x \leq 0.90$). The point 1 represents the location of the kink in the locus, if it exists. Accordingly, the intervals Δt_1 and Δt_2 represent the time required for the pressure wave to travel a distance Δx_1 or a distance of one chord length, respectively. Two wave velocities, normalized with respect to the freestream velocity, will be calculated from these parameters: the average normalized wave velocity for propagation over the entire chord,

$$\bar{V}_w = \frac{c}{V\Delta t_2} \tag{7}$$

and the initial normalized wave velocity for propagation over the leading edge region up to the kink in the locus,

$$V_{w_1} = \frac{c\,\Delta x_1}{V\Delta t_1} \tag{8}$$

If no kink exists it is assumed that the initial and the average wave velocities are the same and only Eq. (7) is used.

Some examples of the use of these procedures are found in Figs. 14 and 15 for frequencies of 31 and 75 Hz, respectively. These are expanded memo scope plots in which less than a full period was displayed to yield greater accuracy in the region of dynamic stall cell propagation. The upper portions of these figures are again the time histories for 11, 14, and 16 deg mean incidence angle, but the viewpoint is now different. Whereas in previous plots a three-dimensional effect was attained by viewing the pseudo-surface from some elevated position, the viewpoint in Figs. 14 and 15 is from ground level. In other words, only the leading edge pressure was referenced to the horizontal datum in previous figures while all time histories are referenced to the horizontal datum in Figs. 14 and 15.

The lower portions of these figures are again the constant altitude contour plots, but these now have superposed ridge line loci as in the schematic of Fig. 13. It is interesting to note that the time histories for f = 31 Hz in Fig. 14 have virtially no secondary pressure waves and the corresponding ridge line loci are relatively straight, with only minor kinks. Conversely the time histories for f = 75 Hz in Fig. 15 all have both secondary and tertiary pressure waves that are quite prominent. For both α_M = 11 deg and α_M = 14 deg the secondary wave seems to merge with the primary wave and a pronounced kink is evident for the contour plots for these two cases. Note, however, that for α_M = 16 deg the secondary wave remains distinct to the extent that many of the contour lines have two extrema and the locus of the primary ridge is not kinked. This lends credence to the assertion made earlier that the kinks appear to be associated with wave coalescence.

Normalized wave velocities, both average and initial, were calculated for all frequencies over the range α_M = 11 deg to α_M = 18 deg and are plotted in various forms in the next several figures. In Fig. 16 these wave velocities are plotted versus airfoil reduced frequency and it is immediately evident that: 1) all wave velocities are consistently less than one-half the free-stream velocity, 2) the initial wave velocities are consistently less than one-third the free-stream velocity, 3) the wave velocities at each mean angle of attack are reasonable well correlated (see next figure), and 4) the wave velocities are strong functions of oscillatory blade frequency, varying almost directly with k.

The correlation alluded to above is well depicted in Fig. 17 in which the wave velocities are cross-plotted versus mean incidence angle. With some exceptions these plots are generally horizontal, indicating that the wave propagation phenomenon is not a strong function of incidence angle, once the stall cell has broken away from the leading edge. Additional insight is afforded by defining two additional correlative parameters, the reduced wave velocity (average and initial),

$$\left.\begin{aligned} \bar{\nu}_w &= \bar{V}_w/k \\ \nu_{w_1} &= V_{w_1}/k \end{aligned}\right\} \tag{9}$$

and the average and initial wave number

$$\bar{k}_w = 1/\bar{\nu}_w$$
$$k_{w_1} = 1/\nu_{w_1} \tag{10}$$

With these definitions the wave propagation phenomenon can be well correlated within a relatively narrow band of parameter values as shown in Figs. 18 and 19.

Comparisons were made with results from other experimental programs (Refs. 8, 20, 21, and 22) and the results are shown in Fig. 20. Pressure time histories presented in these references were examined and the chordwise propagation of peak pressure was used to compute an approximate average chordwise propagation rate for each case. A variety of airfoils were used in these other studies, both thick and thin, including the NACA 0012, NACA 0006, and two Boeing profiles. Other primary parameters also differed from those of the UARL experiment, such as M, α_M, and $\bar{\alpha}$. All of these parameters are listed in the box at the top of the figure, together with the source of the data (reference and figure number), keyed to the symbol used in the plot. The present results from Fig. 16 (for the average normalized wave velocity) are indicated by the envelope curves surrounding the grey area.

Two important results are contained in Fig. 20. The first is the obvious one, that in all cases the wave velocity is considerably less than the free-stream velocity, and the frequency trend followed by most of the data from other sources is similar to that of the present study. The second is revealed by noting that all data points lying below the envelope curve had amplitudes of approximately $\bar{\alpha}$ = 5 deg, the data in the current study had amplitudes of $\bar{\alpha}$ = 8 deg, and the single point from Ref. 20, which is above the envelope curve had an amplitude of $\bar{\alpha}$ = 15 deg. It is true that these data also had significant Mach number and shape difference, but these differences do not tend to separate the data as much as the amplitude differences. Thus, it may be tentatively concluded that increasing the amplitude of motion tends to increase the wave velocity associated with separation.

Harmonic Data Analysis

The first harmonic pressure amplitude, $A_1(x)$, has been plotted versus x in Fig. 21 for α_M = 3, 11, 14, and 18 deg. Similar plots for $A_2(x)$ are found in Fig. 22. For α_M = 3 deg a single frequency, f = 50 Hz, is shown because of the lack of significant variation with f in both first and second harmonics (cf. Table II). All frequencies are plotted for the other three mean incidence angles. In Fig. 21 it is seen that an increase in α_M generally causes a decrease in the first harmonic amplitude near the leading edge but has little effect on A_1 over the aft portion of the chord. In Fig. 22, the second harmonic amplitude increases from a negligibly small level at α_M = 3 deg to a measurable but still small value at higher incidence angles. The effect of increasing frequency is to increase the first harmonic amplitude for all cases examined (Fig. 21). A similar but less pronounced trend also occurs for the second harmonic amplitude over the aft portion of the airfoil, as shown in Fig. 22. However, an opposite trend in which an increase in f causes a decrease in second harmonic amplitude, occurs near the leading edge for intermediate values of α_M. Cross plotted data are shown in Figs. 23 and 24 for the leading edge station for first and second harmonic pressure amplitude versus reduced frequency. Again it is seen that the first harmonic generally increases with k (Fig. 23) while the second harmonic generally decreases with k (Fig. 24). The notable exceptions to the latter are α_M = 3 deg which is very small, and α_M = 18 deg.

Figures 25 and 26 contain representative chordwise variations in first and second harmonic pressure phase angles. Only the 50 Hz first harmonic data is shown for α_M = 3 deg in Fig. 25 because other frequencies for this angle were shown previously in Fig. 6. It is seen that the primary effect of increasing incidence angle on the first harmonic phase angle is to shift the distribution from leading edge lag (negative phase angle) at low α_M to leading edge lead (positive phase angle) at high α_M. In the latter case the phase angle distribution is strongly associated with the rearward propagation of the stall cell or pressure wave. The effect of increasing frequency at low incidence, say α_M = 11 deg, is to switch the behavior from a relatively level trend at f = 12.5 Hz to one with leading edge lag at f = 98.5 Hz, which is a change towards potential flow. This trend is also seen at higher values of α_M, but here the chordwise phase angle distribution never reaches a condition of leading edge lag.

In Fig. 26 only the α_M = 14 deg condition is shown for the second harmonic phase angle distribution. The second harmonic amplitudes are so small at low α_M that the second harmonic phase angles are rendered meaningless, and the distributions at values of α_M greater than 14 deg are much the same as those at 14 deg. It is seen that there is a considerably wider phase variation over the chord than in the first harmonic distribution, and that the second harmonic wave at the leading edge leads the trailing edge, implying a rearward wave propagation here also.

Analysis of Ramp Cam Data

A complete description of the ramp cam test is given in Ref. 17, and only a brief discussion, pertinent to the analysis performed will be given here. Figure 27 shows the incidence angle schedule, relative to mean incidence, for the forward ramp cam. The upstroke region, CDAB, was designed to have a constant angular velocity (excluding the corner regions) that is twice that of the downstroke region, BC. The cam was also operated backwards in which case the upstroke region had an angular velocity that was one-half that of the downstroke region. This is summarized in Table V in which $A = c\dot{\alpha}/2V$, the angular velocity parameter, is tabulated for the cases studied in Ref. 17. The nominal first harmonic frequency, f_1, is the reciprocal of the period of one cycle of motion. (See Table I for a complete listing of the individual cases run.)

It is seen in Table V that certain pairings of conditions have equal angular velocities. For example, a forward upstroke at f = 7.5 Hz and a backward upstroke at f = 14.3 Hz both have A = 0.0020, and a forward downstroke at f = 20 Hz and a backward downstroke at f = 10 Hz both have A = -0.0028. This design was specifically chosen to match angular velocities in these local regions during an upstroke (or a downstroke) while having large differences during a downstroke (or an upstroke) within one cycle of motion. This separate matching of upstroke and downstroke regions is shown schematically in the upper and lower panels of Fig. 28 in which the solid line represents a forward motion and the dashed line represents a backward motion. (Note that these are idealizations of the actual motions which did not have sharp corners.) For upstroke matching, the forward motion frequency is half that of the backward motion and matching occurs over CDAB. For downstroke matching, the forward motion frequency is twice that of the backward motion and matching occurs over BC. In Ref. 17 these regions were examined using integrated normal force and moment loops as a basis of comparison. In general, it was found that equal angular velocities yielded nearly equal integrated results.

A more detailed examination is possible using the pressure time histories, and for this purpose separate time domains were considered. First, the dimensionless upstroke time, t_U, is defined over the upstroke region from the zero displacement point, A, to the maximum displacement point, B, normalized with respect to the time interval over AB (see Fig. 27). Similarly, the dimensionless downstroke time, t_D, is defined over the downstroke region from maximum displacement, B, to minimum displacement, C, normalized with respect to the time interval over BC. In the latter case the entire downstroke region BC is considered because stalling, which usually occurs prior to the peak amplitude, continues over much of the downstroke region, followed by stall recovery near the end of the region. Conversely, only half the upstroke is needed because stall does not usually occur until well beyond the mean incidence angle.

Matching angular velocity regions for α_M = 11 and 14 deg are examined in detail for χ = 0.0119 and 0.2583 in Figs. 29 through 32. In each of these figures the solid lines are for forward motion and the dashed lines are for backward motion. In all cases the differences between forward and backward motions are greater for α_M = 11 deg (Figs. 29 and 30) than for α_M = 14 deg (Figs. 31 and 32). In particular, Fig. 29 shows the results for α_M = 11 deg over the upstroke region AB of Fig. 28. For the lower angular velocity, A = 0.0020, the forward and backward pressure response is in reasonably good agreement, indicating the initiation of stall at the leading edge near $t_u \cong 0.5$ to 0.6. Since there is a nearly linear angular variation this would correspond to an incidence angle of approximately 15 to 16 deg. A wider disagreement is found at A = 0.0028, with large differences in the time at which the various events occur for forward and backward motions. In Fig. 30 for the downstroke region BC at α_M = 11 deg there is a large discrepancy at A = -0.0020 but good agreement at A = -0.0028. Note that the flat region in the pressure at low t_D followed by a sudden rise and a gradual decline as t_D increases represents the process of stall recovery (during the sharp rise) followed by decreasing pressure along a nearly linear characteristic as α decreases. Thus Fig. 30 indicates that at the lower (in magnitude) of the two angular velocities the backward motion experienced a less severe stall than did the forward motion. In contrast, Figs. 31 and 32 for the upstroke and downstroke regions at α_M = 14 deg show very good agreement throughout. This would indicate that at α_M = 11 deg the airfoil penetration into stall is not sufficiently deep to cause a large stall effect under all circumstances whereas at α_M = 14 deg the additional 3 deg penetration into stall causes a more complete stall. It also appears that, for the limited range of parameters considered here, at low incidence the stalling behavior is dependent on past history (i.e., the large differences in angular velocity in the preceding upstroke or downstroke region) while at high incidence the stalling behavior is more dependent on local conditions such as the instantaneous value of A.

Further clarification may be obtained from Figs. 33 and 34 which are the memo scope photographs for α_M = 11 and 14 deg corresponding to eight of the cases just considered. In each figure the upper row is for forward motion while the bottom row is for backward motion. In the left columns the upstroke angular velocity has been matched and in the right columns the downstroke angular velocity has been matched (corresponding to the left hand panels in Figs. 29 through 32). In particular, consider the right column of Fig. 33 which shows qualitatively the disagreement between the curves for A = -0.0020 in Fig. 30. As stated earlier, the backward motion in this case does not stall so deeply that an abrupt recovery occurs while the forward motion does. Again, in contrast, Fig. 34 shows that for α_M = 14 deg there is good qualitative agreement between forward and backward motions in the appropriate matching regions. Indeed, there is generally similar behavior in all regions for this higher incidence angle, with a precipitous stall followed by a flat deep stall region, followed by an abrupt stall recovery.

CONCLUDING REMARKS

As a result of this investigation additional insight has been gained in the study of the dynamic stall phenomenon. An ultimate solution and understanding of this problem, however, will be obtained only when sufficient experimental data have been gathered and analyzed, and when more powerful theoretical techniques have been employed. Hence, the following list contains a set of tentative conclusions obtained from this study which are accurate and valid within the present framework, but which should be tested further as additional work is completed. First, for sinusoidal motion, the conclusions are:

1. The dynamic stall phenomenon is characterized by a pressure wave which propagates from leading to trailing edge and is sometimes accompanied by secondary and tertiary waves.

2. The average pressure wave velocity for rearward propagation over the entire chord is consistently less than one-half the free-stream velocity.

3. The initial pressure wave velocity for rearward propagation in the vicinity of the leading edge is always less than or equal to the average wave velocity, and is consistently less than one-third the free-stream velocity.

4. If the initial wave velocity is significantly different from the average wave velocity it is usually associated with the coalescence of a secondary pressure wave with the primary wave.

5. The pressure wave velocity is a strong function of reduced frequency, varying directly with reduced frequency.

6. The pressure wave velocity is a weak function of mean incidence angle and does not vary significantly with changes in incidence.

7. Correlation with the results of other investigations indicates that increasing the amplitude of motion increases the wave velocity, but in all cases considered the wave velocity remains less than one-half the free-stream velocity.

8. Near the leading edge the first harmonic pressure amplitude generally increases with increasing frequency while the second harmonic amplitude decreases.

9. As mean incidence angle is increased the first harmonic chordwise pressure phase angle shifts from leading edge lag at low incidence to leading edge lead at high incidence. This trend is modified by increasing frequency which causes the leading edge lead at high incidence to be diminished.

10. At low incidence angles the results are in good agreement with potential theory.

11. At intermediate incidence angles, in a mixed flow condition, dynamic stall occurs near the end of the upstroke of the motion. Within the same cycle a potential flow condition exists over the beginning of the upstroke, which is terminated by stall inception. As the reduced frequency is increased the potential flow region persists to higher mean angles of attack.

12. An increase in frequency at high incidence generally decreases the severity of the dynamic stall, although stall recovery appears to be independent of frequency.

For ramp cam motions the conclusions are:

1. At high mean incidence angles in which stall penetration is deep, the stalling behavior is primarily dependent on local conditions such as the instantaneous value of the angular velocity of motion.

2. At intermediate mean incidence angles, in which stall penetration is less deep, the stalling behavior appears to be more dependent on past history than on local conditions.

United Aircraft Research Laboratories
United Aircraft Corporation
East Hartford, Connecticut, September 28, 1973

REFERENCES

1. Bratt, J. B.; and Scruton, C.: Measurements of Pitching Moment Derivatives for an Aerofoil Oscillating About the Half-Chord Axis. R. & M. No. 1921, British A.R.C., November 1938.

2. Victory, M.: Flutter at High Incidence. R. & M. No. 2048, British A.R.C., January 1943.

3. Halfman, R. L.; Johnson, H. C.; and Haley, S. M.: Evaluation of High-Angle-of-Attack Aerodynamic-Derivative Data and Stall-Flutter Prediction Techniques. NACA TN 2533, November 1951.

4. Rainey, A. G.: Measurement of Aerodynamic Forces for Various Mean Angles of Attack on an Airfoil Oscillating in Pitch and on Two Finite-Span Wings Oscillating in Bending with Emphasis on Damping in the Stall. NACA Report 1305, 1957 (Supersedes NACA TN 3643).

5. Carta, F. O.: Experimental Investigation of the Unsteady Aerodynamic Characteristics of an NACA 0012 Airfoil. United Aircraft Research Laboratories Report M-1283-1, August 1960.

6. Carta, F. O.; and Niebanck, C. F.: Prediction of Rotor Instability at High Forward Speeds. Volume III, Stall Flutter. USAAVLABS Technical Report 68-18C, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia, February 1969, AD 687322.

7. Arcidiacono, P. J.; Carta, F. O.; Casellini, L. M.; and Elman, H. L.: Investigation of Helicopter Control Loads Induced by Stall Flutter. USAAVLABS Technical Report 70-2, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia, March 1970.

8. Liiva, J.; Davenport, F. J.; Gray, L; and Walton, I. C.: Two-Dimensional Tests of Airfoils Oscillating Near Stall. Vol. I, Summary and Evaluation of Results. USAAVLABS Technical Report 68-13A, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia.

9. Gray, L.; and Liiva, J.: Two-Dimensional Tests of Airfoils Oscillating Near Stall. Vol. II, Data Report. USAAVLABS Technical Report 68-13B, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia, April 1968.

10. Ham, N. D.: Aerodynamic Loading on a Two-Dimensional Airfoil During Dynamic Stall. AIAA Journal, Vol. 6, No. 10, October 1968, pp. 1927-1934.

11. Isogai, K: An Experimental Study on the Unsteady Behavior of a Short Bubble on an Airfoil During Dynamic Stall With Special Reference to the Mechanism of the Stall Overshoot Effect. M.I.T. Aeroelastic and Structures Research Lab. Report. ASRL TR 130-2, June 1970.

12. McCroskey, W. J.; and Fisher, R. K.: Detailed Aerodynamic Measurements on a Model Rotor in the Blade Stall Regime. Journal of the American Helicopter Society, Vol. 17, No. 1, January 1972, pp. 20-30.

13. Ham, N. D.: Some Recent Research on Airfoil Dynamic Stall With Application to Airfoil Design. M.I.T. Aeroelastic and Structures Research Laboratory Report ASRL TR 165-1, September 1971.

14. Carta, F. O.: Effect of Unsteady Pressure Gradient Reduction on Dynamic Stall Delay. AIAA Journal of Aircraft, Vol. 8, No. 10, October 1971, pp. 839-841.

15. McCroskey, W. J.: Inviscid Flowfield of an Unsteady Airfoil. AIAA Journal, Vol. 11, No. 8, August 1973, pp. 1130-1137.

16. Crimi, P.; and Reeves, B. L.: A Method for Analyzing Dynamic Stall of Helicopter Rotor Blades. NASA CR-2009, May 1972.

17. Carta, F. O.; Commerford, G. L.; Carlson, R. G.; and Blackwell, R. H.: Investigation of Airfoil Dynamic Stall and Its Influence on Helicopter Control Loads. USAAMRDL Technical Report 72-51, U. S. Army Air Mobility Research and Development Laboratory, Fort Eustis, Virginia, Sept. 1972.

18. Blackman, R. B.; and Tukey, J. W.: The Measurement of Power Spectra From the Point of View of Communications Engineering, Part I. Bell System Technical Journal, Vol. 37, 1958, pp. 185-282.

19. Oliver, B. M.; and Cage, J. M., editors: Electronic Measurements and Instrumentation. McGraw-Hill Book Company, Inc., New York, 1971.

20. Martin, J. M.; Empey, R. W.; McCroskey, W. J.; and Caradonna, F. X.: A Detailed Experimental Analysis of Dynamic Stall on an Unsteady Two-Dimensional Airfoil. A.H.S. Preprint No. 702, Presented at the 29th Annual National Forum of the American Helicopter Society, May 1973.

21. Gray, L.; Liiva, J.; and Davenport, F. J.: Wind Tunnel Tests of Thin Airfoils Oscillating Near Stall. Volume I. Summary and Evaluation of Results. USAAVLABS Technical Report 68-89A, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia, January 1969.

22. Gray, L.; and Liiva, J.: Wind Tunnel Tests of Thin Airfoils Oscillating Near Stall. Volume II. Data Report. USAAVLABS Technical Report 68-89B, U. S. Army Aviation Materiel Laboratories, Fort Eustis, Virginia, January 1969.

TABLE I.

TEST CONDITIONS ANALYZED

Sinusoidal Motion, $\overline{\alpha}$ = 8 deg

α_M =	3	6	9	11	12	14	16	18	Average Frequency f	Nominal Frequency	Average Reduced Frequency k
f =	10.02	12.37	12.35	12.57	12.56	12.52	12.52	12.47	12.48*	12.5*	.0419*
	31.01	30.90	31.30	31.27	31.01	30.91	30.99	30.96	31.04	31.0	.1042
	50.20	50.20	50.68	50.34	49.34	49.21	49.64	50.06	49.96	50.0	.1677
	74.60	75.29	75.23	75.25	74.59	75.17	73.98	74.68	74.85	75.0	.2512
	98.27	98.45	98.50	98.56	98.72	98.81	98.56	98.64	98.56	98.5	.3308

*Not including value for α_M = 3 deg

Ramp Motion, $\overline{\alpha}$ = 8 deg

	Forward ramp			Backward Ramp		
α_M =	6	11	14	6	11	14
f_1 =	7.46	7.57	7.55	7.56	7.54	7.63
	9.89	9.99	9.96	10.02	9.91	9.89
	14.19	14.20	14.19	14.09	14.13	14.12
	19.88	19.74	19.75	19.92	19.90	19.73

TABLE II. - PRESSURE HARMONICS FOR SINUSOIDAL MOTION

MEAN ANGLE = 3.00000 DEG   FREQUENCY = 10.02045 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	1.3114	3.0843	.0981	.0235	.0055	.0055	.0100	.0004	.0037	.0043	.0015
.0615	.3463	2.1716	.0230	.0325	.0145	.0122	.0234	.0007	.0035	.0047	.0064
.1462	-.2796	1.2341	.0044	.0075	.0045	.0043	.0102	.0035	.0019	.0057	.0018
.2583	.2113	.7788	.0120	.0043	.0047	.0034	.0050	.0019	.0021	.0015	.0027
.3881	.2552	.5200	.0138	.0043	.0080	.0006	.0085	.0005	.0028	.0005	.0006
.5238	.6513	.3933	.0101	.0027	.0079	.0016	.0055	.0030	.0007	.0027	.0013
.6536	.0721	.2857	.0086	.0012	.0037	.0015	.0039	.0009	.0006	.0002	.0004
.7657	-.3384	.2042	.0075	.0006	.0021	.0002	.0041	.0004	.0004	.0006	.0004
.8504	-.1106	.1462	.0043	.0018	.0026	.0005	.0080	.0010	.0009	.0014	.0003
.9000	-.1445	.1275	.0078	.0018	.0016	.0013	.0038	.0007	.0003	.0011	.0004

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	.53	271.26	196.58	238.75	326.18	303.24	2.68	278.10	311.02	4.58
.0615	.20	73.07	348.70	250.24	359.54	292.40	27.42	306.74	229.73	69.65
.1462	1.83	290.51	335.15	223.73	333.21	325.47	347.46	282.53	356.09	75.41
.2583	2.45	274.86	230.68	252.34	183.84	313.85	173.60	256.20	248.67	53.67
.3881	4.27	272.87	198.01	266.37	207.87	291.38	54.93	278.13	343.20	286.26
.5238	5.64	272.95	214.25	261.96	344.61	277.39	353.10	283.66	337.57	72.37
.6536	7.64	269.95	323.11	257.96	340.80	344.74	2.31	39.95	239.35	123.25
.7657	7.07	276.22	279.32	261.82	352.76	322.63	124.07	88.68	349.78	296.82
.8504	11.42	78.64	218.34	274.26	213.09	125.61	171.03	7.02	289.06	211.93
.9000	9.66	267.46	344.59	89.13	177.93	281.83	323.13	153.56	327.64	85.89

MEAN ANGLE = 3.00000 DEG   FREQUENCY = 31.01048 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	1.1785	2.9809	.0942	.0372	.0047	.0064	.0052	.0030	.0012	.0139	.0054
.0615	.5718	2.1038	.0299	.0203	.0112	.0093	.0092	.0058	.0056	.0155	.0048
.1462	.2893	1.1075	.0057	.0040	.0013	.0031	.0039	.0011	.0029	.0085	.0045
.2583	.2516	.7480	.0075	.0084	.0039	.0028	.0014	.0037	.0016	.0058	.0003
.3881	.2219	.5014	.0100	.0071	.0060	.0006	.0038	.0013	.0005	.0028	.0033
.5238	.2115	.3912	.0080	.0041	.0050	.0015	.0027	.0009	.0009	.0018	.0019
.6536	.1467	.2883	.0052	.0009	.0026	.0020	.0010	.0009	.0019	.0012	.0028
.7657	.0190	.2011	.0039	.0003	.0008	.0018	.0012	.0014	.0008	.0005	.0010
.8504	.0280	.1555	.0049	.0015	.0013	.0016	.0033	.0011	.0016	.0048	.0026
.9000	-.0008	.1240	.0069	.0010	.0026	.0019	.0004	.0005	.0013	.0016	.0021

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	351.58	245.02	148.61	116.04	279.15	90.61	322.39	296.68	191.76	55.95
.0615	358.11	47.26	307.53	190.22	311.69	166.52	51.94	304.03	151.30	23.23
.1462	356.06	9.15	245.62	80.45	275.05	86.14	24.32	347.25	204.08	110.24
.2583	357.80	272.61	171.10	250.04	122.67	189.14	82.89	283.90	157.44	88.16
.3881	4.58	262.67	161.89	237.44	9.25	198.07	25.81	311.25	221.29	169.60
.5238	7.81	253.39	156.35	205.12	265.40	141.49	248.24	338.04	221.53	154.53
.6536	10.87	254.41	154.69	251.15	314.60	61.69	51.93	2.90	264.48	161.55
.7657	17.71	314.99	183.10	339.95	44.53	31.26	69.81	18.36	171.51	279.79
.8504	23.21	246.18	256.88	273.17	87.84	351.64	303.73	180.87	1.80	204.27
	22.17	269.49	313.57	24.12	57.65	69.91	49.11	323.29	111.70	227.59

TABLE II. - CONTINUED

MEAN ANGLE = 3.00000 DEG FREQUENCY = 50.20122 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	1.3184	3.0116	.0989	.0357	.0061	.0109	.0071	.0099	.0066	.0070	.0029
.0615	.0463	2.0825	.0306	.0192	.0079	.0082	.0068	.0083	.0034	.0077	.0034
.1462	.6539	1.1631	.0061	.0043	.0035	.0043	.0057	.0074	.0025	.0017	.0017
.2583	.2826	.7748	.0096	.0068	.0046	.0038	.0074	.0008	.0035	.0041	.0026
.3881	.2348	.5360	.0115	.0039	.0040	.0035	.0048	.0060	.0028	.0028	.0006
.5238	.3076	.4004	.0078	.0050	.0003	.0028	.0021	.0061	.0044	.0050	.0017
.6536	.1120	.3085	.0040	.0021	.0039	.0039	.0026	.0058	.0028	.0043	.0016
.7657	-.0652	.2118	.0029	.0025	.0024	.0033	.0031	.0068	.0045	.0047	.0017
.8504	-.0454	.1843	.0014	.0056	.0020	.0043	.0018	.0035	.0036	.0042	.0022
.9000	.0596	.1305	.0112	.0026	.0054	.0036	.0043	.0061	.0053	.0059	.0024

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	349.81	240.95	136.24	35.61	248.50	36.94	155.77	126.83	7.10	192.68
.0615	351.84	54.16	306.22	189.76	283.02	155.51	140.17	212.47	59.32	255.61
.1462	356.88	322.86	263.95	28.53	251.09	54.97	193.39	187.10	77.60	185.41
.2583	2.96	270.61	168.14	282.49	108.79	192.74	209.19	261.51	113.10	226.26
.3881	10.44	256.50	153.74	231.62	326.56	150.66	255.57	231.77	136.43	250.51
.5238	18.82	252.34	121.66	159.79	333.30	122.22	241.82	274.89	124.07	250.39
.6536	27.14	268.12	76.80	22.06	346.22	83.99	262.45	267.04	117.96	286.61
.7657	34.57	11.85	114.47	12.90	57.93	215.90	319.31	308.60	204.29	26.46
.8504	32.58	59.27	215.95	320.68	328.88	144.36	296.20	266.22	121.39	347.24
.9000	46.35	281.76	110.54	328.33	82.96	241.23	323.87	340.57	196.12	6.45

MEAN ANGLE = 3.00000 DEG FREQUENCY = 74.59557 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	1.3592	3.0406	.0935	.0333	.0025	.0377	.0062	.0018	.0031	.0009	.0014
.0615	.0456	2.0907	.0423	.0231	.0090	.0243	.0089	.0026	.0005	.0090	.0054
.1462	.6359	1.1859	.0079	.0051	.0056	.0193	.0055	.0044	.0009	.0022	.0010
.2583	.2889	.7782	.0069	.0046	.0125	.0136	.0028	.0031	.0017	.0035	.0014
.3881	.2399	.5589	.0082	.0006	.0035	.0187	.0018	.0037	.0016	.0030	.0013
.5238	.3377	.4387	.0043	.0028	.0048	.0195	.0044	.0010	.0006	.0041	.0005
.6536	.0810	.3538	.0028	.0044	.0057	.0212	.0039	.0030	.0025	.0041	.0005
.7657	-.0781	.2390	.0063	.0023	.0042	.0207	.0026	.0040	.0027	.0077	.0019
.8504	-.0673	.2309	.0027	.0009	.0050	.0109	.0015	.0006	.0016	.0021	.0005
.9000	.0810	.1586	.0186	.0049	.0084	.0256	.0067	.0043	.0019	.0103	.0016

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	345.90	228.56	108.20	256.25	117.85	320.50	246.43	327.62	286.45	118.71
.0615	348.76	50.01	302.00	208.01	154.12	164.20	341.66	54.47	345.27	230.78
.1462	356.61	359.77	280.45	302.44	179.39	350.11	174.16	343.13	66.71	129.79
.2583	5.44	266.31	172.26	285.33	203.95	245.33	337.30	140.86	76.36	221.80
.3881	16.83	233.17	41.13	255.94	222.03	39.37	250.43	65.44	89.76	254.09
.5238	27.82	230.92	58.79	348.35	222.88	347.39	182.03	138.74	50.34	189.61
.6536	39.10	149.76	356.34	350.22	234.96	353.49	267.34	37.49	45.63	243.14
.7657	50.49	61.82	319.01	350.06	287.32	122.65	342.88	174.34	127.10	334.40
.8504	46.00	245.64	42.93	303.64	236.01	319.99	299.60	131.58	60.31	342.49
.9000	73.49	277.16	86.30	346.50	298.[illegible]7	64.29	293.60	169.19	137.41	338.41

TABLE II. - CONTINUED

MEAN ANGLE = 3.00000 DEG FREQUENCY = 98.26901 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	1.4025	3.1084	.1018	.0317	.0087	.0153	.0012	.0044	.0002	.0010	.0022
.0615	.0355	2.1398	.0499	.0249	.0152	.0053	.0091	.0083	.0044	.0033	.0040
.1462	.6226	1.2102	.0065	.0065	.0022	.0053	.0044	.0037	.0023	.0026	.0019
.2583	.2898	.8043	.0060	.0056	.0063	.0077	.0017	.0036	.0043	.0020	.0018
.3881	.2545	.6050	.0064	.0059	.0053	.0051	.0025	.0038	.0024	.0014	.0021
.5238	.3692	.5059	.0048	.0090	.0011	.0083	.0043	.0031	.0028	.0012	.0009
.6536	.0818	.4233	.0083	.0065	.0022	.0084	.0035	.0008	.0024	.0014	.0013
.7657	-.0941	.2955	.0140	.0039	.0030	.0070	.0093	.0047	.0039	.0018	.0020
.8504	-.0817	.2897	.0024	.0085	.0045	.0051	.0019	.0021	.0008	.0014	.0012
.9000	.0988	.2219	.0358	.0152	.0086	.0095	.0152	.0134	.0021	.0042	.0012

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	347.02	221.86	95.45	85.59	44.79	35.69	345.13	168.38	89.18	145.47
.0615	351.40	52.88	303.35	142.45	70.64	198.45	31.85	27.86	335.81	198.61
.1462	1.70	21.42	334.80	284.92	118.53	344.10	158.10	30.33	153.33	181.05
.2583	13.70	242.96	100.70	240.68	134.49	250.03	232.42	164.74	348.17	176.08
.3881	27.43	211.55	51.36	191.55	170.37	15.93	178.77	78.78	104.12	209.24
.5238	39.36	195.82	42.14	326.26	170.69	322.41	122.47	149.89	347.10	139.83
.6536	51.24	98.37	67.49	305.09	182.32	301.26	185.36	95.12	311.93	261.39
.7657	66.54	79.84	36.10	293.24	273.95	65.71	227.66	179.29	30.47	219.11
.8504	56.66	222.04	36.11	271.00	170.76	339.63	133.50	123.24	204.14	38.45
.9000	101.64	277.33	105.05	281.42	281.77	44.01	206.62	200.86	103.56	214.45

MEAN ANGLE = 6.00000 DEG FREQUENCY = 12.36941 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.6108	3.2328	.1216	.0283	.0256	.0064	.0055	.0019	.0023	.0012	.0025
.0615	1.4446	2.1038	.0784	.0349	.0119	.0097	.0115	.0070	.0021	.0068	.0046
.1462	.8467	1.2147	.0318	.0177	.0075	.0024	.0016	.0033	.0021	.0019	.0017
.2583	.6267	.7769	.0117	.0109	.0080	.0078	.0027	.0027	.0014	.0011	.0009
.3881	.4303	.5239	.0110	.0107	.0058	.0059	.0017	.0023	.0017	.0011	.0004
.5238	.3538	.3990	.0075	.0131	.0028	.0033	.0025	.0019	.0010	.0007	.0009
.6536	.2512	.2853	.0067	.0092	.0025	.0017	.0020	.0010	.0011	.0005	.0019
.7657	.0981	.1974	.0076	.0055	.0020	.0023	.0021	.0011	.0008	.0006	.0011
.8504	.0608	.1516	.0041	.0034	.0034	.0014	.0020	.0010	.0019	.0006	.0028
.9000	.0871	.1319	.0037	.0012	.0012	.0008	.0013	.0007	.0006	.0010	.0009

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	355.50	269.82	254.82	203.66	182.26	76.15	110.92	92.73	229.03	134.37
.0615	355.34	64.13	307.60	113.09	302.07	70.38	328.09	97.43	315.69	129.00
.1462	357.16	53.38	303.96	201.96	219.36	152.39	137.26	223.90	122.94	230.79
.2583	357.93	3.64	302.16	220.06	333.35	207.29	339.73	210.16	305.02	113.08
.3881	.27	306.32	312.66	212.87	335.53	99.45	335.24	50.12	131.38	48.01
.5238	1.97	309.53	318.13	200.00	313.68	62.85	101.90	219.29	86.42	188.29
.6536	4.52	26.38	316.36	207.11	259.85	210.71	15.23	320.34	353.91	155.16
.7657	5.56	36.24	315.68	218.95	281.98	195.59	33.57	253.88	94.40	227.08
.8504	10.47	72.53	260.77	245.18	211.89	313.04	113.49	353.41	213.24	43.84
.9000	5.75	330.36	258.12	215.71	16.76	189.41	124.80	242.04	85.73	227.09

TABLE II. - CONTINUED

MEAN ANGLE = 6.00000 DEG   FREQUENCY = 30.90338 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.6420	3.2794	.1717	.0359	.0097	.0062	.0043	.0022	.0021	.0141	.0084
.0615	1.4803	2.1311	.0472	.0292	.0133	.0139	.0092	.0065	.0049	.0103	.0112
.1462	.8645	1.2200	.0164	.0132	.0033	.0025	.0017	.0046	.0026	.0100	.0021
.2583	.6355	.7809	.0178	.0078	.0053	.0047	.0037	.0010	.0012	.0048	.0046
.3881	.4288	.5300	.0199	.0069	.0025	.0060	.0009	.0004	.0019	.0031	.0013
.5238	.3333	.4197	.0139	.0084	.0004	.0022	.0022	.0012	.0011	.0020	.0022
.6536	.2551	.3006	.0059	.0061	.0021	.0004	.0022	.0005	.0003	.0037	.0020
.7657	.1250	.2039	.0044	.0032	.0015	.0009	.0016	.0005	.0008	.0009	.0009
.8504	.0837	.1687	.0091	.0018	.0014	.0010	.0013	.0006	.0018	.0050	.0023
.9000	.0890	.1326	.0053	.0020	.0015	.0002	.0012	.0006	.0009	.0019	.0006

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	352.15	256.37	192.19	195.79	190.80	37.96	22.72	290.14	220.05	41.04
.0615	351.24	28.23	267.32	68.92	261.84	27.32	280.74	74.66	234.87	73.84
.1462	356.66	11.35	252.97	221.37	227.58	322.11	106.72	226.34	240.22	125.80
.2583	353.27	292.28	226.48	218.46	325.42	199.67	214.55	87.49	245.49	56.84
.3881	4.73	274.62	264.62	200.64	300.70	74.14	298.40	322.82	254.43	68.52
.5238	7.39	273.42	275.60	113.29	277.11	303.36	75.76	153.62	291.33	132.26
.6536	15.01	306.45	266.86	136.91	348.22	202.65	344.19	287.26	277.73	120.23
.7657	19.10	342.01	243.73	202.26	282.09	161.33	86.79	144.40	353.31	39.23
.8504	22.72	336.31	242.62	204.14	14.16	187.09	338.46	129.03	43.51	206.26
.9000	26.56	267.61	173.60	242.16	68.63	176.88	100.25	217.05	39.83	176.39

MEAN ANGLE = 6.00000 DEG   FREQUENCY = 50.19642 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.6099	3.1548	.1593	.0282	.0032	.0109	.0093	.0129	.0048	.0054	.0009
.0615	.9354	2.0073	.0544	.0172	.0134	.0154	.0115	.0095	.0017	.0004	.0028
.1462	1.3288	1.1632	.0200	.0044	.0024	.0030	.0019	.0044	.0036	.0034	.0012
.2583	.6187	.7727	.0204	.0022	.0006	.0073	.0021	.0058	.0012	.0028	.0006
.3881	.4037	.5429	.0195	.0025	.0022	.0061	.0028	.0059	.0027	.0041	.0008
.5238	.3095	.4092	.0225	.0023	.0024	.0045	.0016	.0060	.0029	.0030	.0006
.6536	.2811	.3078	.0086	.0053	.0018	.0009	.0047	.0063	.0037	.0041	.0005
.7657	.1666	.2098	.0053	.0045	.0013	.0021	.0041	.0051	.0032	.0039	.0011
.8504	.1539	.1885	.0078	.0030	.0035	.0066	.0054	.0040	.0039	.0011	.0028
.9000	.1134	.1334	.0126	.0080	.0017	.0046	.0036	.0083	.0031	.0035	.0010

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	351.79	252.39	159.06	210.53	215.85	36.28	150.19	92.96	26.43	207.23
.0615	354.16	36.17	274.85	59.37	272.72	59.21	213.85	164.71	92.07	128.80
.1462	359.20	3.19	240.13	17.97	266.08	59.67	187.71	230.70	82.25	202.60
.2583	4.78	291.82	181.20	167.70	310.81	245.24	273.95	280.20	167.00	55.93
.3881	11.91	275.03	161.36	38.25	300.03	106.95	243.10	263.28	122.05	269.09
.5238	19.51	258.47	254.38	347.98	290.61	136.40	266.81	247.69	137.53	285.85
.6536	27.99	274.71	154.23	232.23	253.04	162.15	250.55	244.65	151.70	266.78
.7657	36.68	313.28	138.02	105.42	100.22	183.62	309.21	327.93	215.20	75.62
.8504	35.41	300.27	111.98	241.40	24.04	156.00	266.24	215.30	91.00	338.09
.9000	44.17	268.53	93.57	240.48	56.52	182.61	342.34	320.62	223.63	79.86

TABLE II. - CONTINUED

MEAN ANGLE = 6.00000 DEG FREQUENCY = 75.28601 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.6442	3.1641	.1717	.0305	.0164	.0439	.0109	.0061	.0020	.0014	.0019
.0615	.9428	2.0062	.0501	.0140	.0101	.0280	.0061	.0109	.0055	.0067	.0059
.1462	1.3064	1.1590	.0124	.0025	.0053	.0161	.0038	.0012	.0015	.0039	.0004
.2583	.6229	.7695	.0183	.0015	.0030	.0134	.0039	.0035	.0008	.0038	.0031
.3881	.4181	.5615	.0176	.0017	.0030	.0182	.0038	.0005	.0014	.0039	.0004
.5238	.3245	.4448	.0195	.0017	.0029	.0176	.0011	.0021	.0019	.0035	.0017
.6536	.2836	.3511	.0033	.0053	.0004	.0159	.0027	.0020	.0008	.0037	.0008
.7657	.1603	.2389	.0030	.0042	.0032	.0180	.0025	.0047	.0047	.0083	.0034
.8504	.1470	.2338	.0048	.0043	.0022	.0115	.0027	.0029	.0016	.0025	.0024
.9000	.1115	.1599	.0170	.0155	.0026	.0282	.0041	.0075	.0086	.0099	.0034

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	346.61	228.65	124.78	203.56	116.97	308.25	131.82	333.90	232.31	46.26
.0615	350.41	39.46	266.62	20.50	161.97	341.35	217.12	29.97	280.73	79.84
.1462	358.46	2.20	202.14	276.40	168.18	297.54	46.52	145.23	1.11	192.45
.2583	6.90	264.03	128.68	177.21	242.73	48.42	293.74	77.25	96.63	298.17
.3881	17.84	245.01	75.54	317.86	226.41	6.99	216.99	127.99	34.40	275.21
.5238	27.85	228.14	207.77	286.26	223.97	78.90	253.82	123.79	61.95	234.04
.6536	39.67	207.45	116.35	309.39	223.90	130.37	235.73	223.04	60.33	281.21
.7657	51.69	70.63	127.07	43.22	298.43	105.84	357.01	198.29	127.48	318.89
.8504	46.42	281.99	66.31	44.57	251.14	78.23	265.45	106.12	81.76	241.34
.9000	77.21	269.77	76.39	11.37	318.58	116.55	327.17	189.42	127.27	294.32

MEAN ANGLE = 6.00000 DEG FREQUENCY = 98.44543 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.7212	3.3027	.1806	.0282	.0076	.0153	.0048	.0026	.0013	.0019	.0035
.0615	.9698	2.0978	.0619	.0159	.0139	.0055	.0128	.0040	.0105	.0093	.0061
.1462	1.3275	1.2130	.0123	.0066	.0006	.0096	.0043	.0036	.0016	.0026	.0026
.2583	.6336	.8130	.0178	.0089	.0048	.0029	.0048	.0037	.0006	.0022	.0018
.3881	.4260	.6181	.0162	.0087	.0009	.0062	.0048	.0015	.0016	.0026	.0008
.5238	.3422	.5145	.0174	.0082	.0027	.0079	.0018	.0035	.0017	.0014	.0021
.6536	.2923	.4282	.0090	.0133	.0012	.0095	.0029	.0029	.0007	.0012	.0012
.7657	.1600	.2946	.0134	.0055	.0025	.0065	.0096	.0046	.0038	.0019	.0009
.8504	.1474	.2916	.0023	.0113	.0029	.0052	.0033	.0017	.0005	.0014	.0008
.9000	.1173	.2186	.0321	.0199	.0078	.0100	.0131	.0135	.0045	.0051	.0016

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	346.74	222.02	80.27	156.14	53.73	239.75	74.14	16.83	104.48	35.37
.0615	351.91	39.21	301.39	62.65	110.63	294.41	155.42	10.44	203.07	61.25
.1462	2.55	11.49	30.83	239.72	78.74	277.26	48.86	27.90	343.43	118.97
.2583	13.57	252.40	91.46	186.63	260.10	38.74	239.39	103.33	38.71	253.90
.3881	26.66	228.18	58.77	196.17	167.11	321.99	102.36	131.87	340.87	104.56
.5238	37.95	204.43	75.95	198.03	142.69	33.83	146.74	93.91	29.63	145.83
.6536	49.83	119.45	101.89	157.69	157.17	344.98	145.58	87.82	27.17	119.53
.7657	65.51	91.24	102.91	278.35	284.17	56.80	228.10	214.43	40.31	244.65
.8504	56.15	135.17	56.04	207.83	194.12	11.80	200.39	165.08	153.52	348.32
.9000	101.83	276.81	99.21	278.45	297.55	51.36	213.16	235.88	100.15	271.30

TABLE II. - CONTINUED

MEAN ANGLE = 9.00000 DEG FREQUENCY = 12.35462 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.6871	2.8114	.4273	.2845	.1263	.0682	.0543	.0411	.0362	.0266	.0191
.0615	2.1458	1.6848	.3780	.1422	.0472	.0489	.0329	.0284	.0254	.0177	.0177
.1462	1.3189	1.0862	.1604	.0727	.0306	.0176	.0259	.0331	.0210	.0168	.0181
.2583	.9023	.7184	.0989	.0514	.0275	.0103	.0158	.0183	.0153	.0100	.0059
.3881	.6458	.5049	.0615	.0289	.0182	.0054	.0076	.0128	.0100	.0059	.0025
.5238	.5169	.4010	.0382	.0178	.0124	.0024	.0093	.0130	.0111	.0067	.0015
.6536	.3896	.3048	.0146	.0175	.0139	.0021	.0086	.0117	.0104	.0073	.0055
.7657	.1910	.2349	.0255	.0234	.0143	.0032	.0073	.0102	.0093	.0065	.0051
.8504	.1350	.2047	.0484	.0329	.0205	.0068	.0048	.0079	.0104	.0082	.0068
.9000	.1723	.1737	.0322	.0206	.0089	.0015	.0046	.0056	.0054	.0043	.0029

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	358.48	37.02	312.09	238.50	184.03	118.19	40.06	326.12	256.38	184.88
.0615	358.70	45.51	302.94	229.50	174.32	109.93	50.66	310.97	212.76	176.93
.1462	.83	23.76	259.50	151.90	103.94	34.27	304.80	218.87	152.90	90.71
.2583	2.47	5.71	248.64	119.82	47.29	5.80	261.57	177.40	90.97	51.42
.3881	4.39	359.14	241.14	82.39	119.00	351.46	257.05	149.27	67.89	30.64
.5238	5.29	352.13	202.23	58.91	54.34	333.01	226.01	121.28	14.51	263.82
.6536	4.40	298.29	136.74	23.22	316.91	308.86	204.06	93.05	349.32	216.37
.7657	1.57	240.04	116.19	8.11	295.24	274.37	173.17	62.84	306.34	181.15
.8504	357.96	220.10	100.91	355.40	290.37	247.20	135.29	32.88	291.91	165.29
.9000	357.28	223.76	99.93	340.63	313.39	250.57	146.85	17.00	247.45	110.60

MEAN ANGLE = 9.00000 DEG FREQUENCY = 31.30462 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.5261	2.6284	.6320	.3864	.1498	.0218	.0345	.0332	.0174	.0306	.0195
.0615	2.2056	1.8680	.3185	.1555	.0684	.0037	.0314	.0284	.0262	.0195	.0169
.1462	1.3713	1.2061	.1274	.0671	.0282	.0458	.0548	.0520	.0360	.0065	.0211
.2583	.9619	.8271	.1060	.0628	.0440	.0216	.0207	.0291	.0210	.0140	.0069
.3881	.6744	.5634	.0675	.0351	.0296	.0095	.0148	.0131	.0126	.0090	.0017
.5238	.5500	.4425	.0480	.0292	.0203	.0101	.0116	.0120	.0084	.0059	.0028
.6536	.3892	.3261	.0307	.0230	.0157	.0059	.0077	.0085	.0066	.0062	.0026
.7657	.1638	.2275	.0239	.0230	.0134	.0007	.0055	.0060	.0036	.0012	.0005
.8504	.0905	.1942	.0238	.0200	.0086	.0011	.0048	.0054	.0047	.0031	.0031
.9000	.1716	.1586	.0271	.0164	.0076	.0024	.0061	.0049	.0033	.0019	.0015

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	359.85	8.58	267.21	165.08	82.24	88.18	340.23	263.72	204.92	112.12
.0615	357.87	352.36	210.49	77.53	47.63	16.24	255.51	153.63	90.85	349.08
.1462	.31	321.88	186.19	103.98	44.82	309.42	202.63	94.21	26.85	337.26
.2583	2.00	287.18	147.56	30.95	308.86	238.84	132.02	21.22	266.24	214.80
.3881	8.61	296.02	149.11	16.07	275.03	192.26	92.63	342.08	222.73	131.82
.5238	11.50	292.65	132.55	357.56	277.33	176.22	66.82	316.91	219.55	119.27
.6536	17.26	279.52	116.37	344.29	282.76	190.70	84.47	342.34	235.89	119.53
.7657	18.73	248.40	88.86	321.30	214.72	182.95	69.35	304.12	220.94	23.56
.8504	17.12	228.12	78.45	297.98	310.25	196.52	54.12	304.25	329.61	147.03
.9000	14.46	223.56	76.34	311.34	263.22	147.24	19.68	244.27	47.12	153.64

TABLE II: CONTINUED

MEAN ANGLE = 9.00000 DEG   FREQUENCY = 50.68052 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.5053	2.7220	.4213	.2783	.1236	.0360	.0491	.0337	.0321	.0175	.0092
.0615	1.7388	1.9301	.1795	.1182	.0792	.0272	.0291	.0520	.0304	.0206	.0124
.1462	1.8266	1.2077	.1047	.0754	.0420	.0280	.0274	.0316	.0221	.0123	.0078
.2583	.9045	.8420	.0975	.0630	.0431	.0308	.0192	.0112	.0155	.0079	.0055
.3881	.6291	.5916	.0572	.0308	.0221	.0148	.0106	.0109	.0085	.0079	.0013
.5238	.4498	.4581	.0454	.0237	.0159	.0073	.0079	.0115	.0055	.0067	.0014
.6536	.3468	.3398	.0332	.0204	.0126	.0019	.0052	.0124	.0058	.0065	.0018
.7657	.2526	.2363	.0227	.0174	.0090	.0032	.0028	.0133	.0030	.0005	.0010
.8504	.1603	.2053	.0201	.0151	.0031	.0063	.0051	.0123	.0057	.0065	.0049
.9000	.1910	.1475	.0254	.0138	.0078	.0028	.0015	.0098	.0039	.0040	.0027

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	4.85	9.82	282.71	189.94	139.53	81.95	331.83	235.19	119.04	79.85
.0615	5.33	338.57	196.99	83.51	2.09	330.54	218.57	119.09	47.00	330.20
.1462	8.18	291.94	152.89	48.14	336.34	261.41	182.76	71.36	344.23	273.54
.2583	13.43	274.41	128.10	17.72	273.05	168.00	76.78	334.82	224.53	178.13
.3881	19.87	269.89	97.60	331.63	200.90	116.72	332.12	268.06	150.15	57.62
.5238	25.40	257.80	74.91	319.69	180.49	109.22	316.21	230.05	141.12	20.74
.6536	32.43	248.24	68.97	293.48	232.18	108.73	319.69	217.48	129.94	32.90
.7657	39.44	232.60	64.26	289.42	197.80	45.49	330.10	197.56	334.53	76.66
.8504	34.10	216.21	50.62	238.85	254.29	113.14	306.23	208.57	97.37	308.29
.9000	40.11	224.89	51.09	222.84	80.16	134.50	328.02	132.54	291.84	194.47

MEAN ANGLE = 9.00000 DEG   FREQUENCY = 75.23221 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.5275	2.7717	.3680	.2857	.1552	.0956	.0475	.0373	.0240	.0191	.0082
.0615	1.7869	2.0487	.1639	.1487	.1051	.0195	.0432	.0466	.0367	.0226	.0118
.1462	1.8476	1.2607	.1147	.1008	.0685	.0460	.0299	.0228	.0176	.0143	.0095
.2583	.9373	.8689	.1001	.0803	.0516	.0363	.0209	.0144	.0143	.0089	.0044
.3881	.6551	.6204	.0477	.0399	.0300	.0186	.0150	.0125	.0082	.0015	.0019
.5238	.4764	.4916	.0380	.0279	.0189	.0022	.0094	.0052	.0053	.0055	.0025
.6536	.3714	.3766	.0268	.0226	.0159	.0075	.0101	.0053	.0039	.0024	.0015
.7657	.2540	.2554	.0263	.0155	.0123	.0196	.0087	.0017	.0036	.0065	.0019
.8504	.1571	.2460	.0181	.0150	.0113	.0086	.0073	.0041	.0011	.0030	.0000
.9000	.1836	.1529	.0187	.0119	.0098	.0319	.0046	.0034	.0053	.0103	.0031

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	359.81	8.07	278.02	182.39	106.28	10.07	274.40	158.96	32.13	281.02
.0615	1.23	304.89	165.22	50.30	308.25	271.34	172.63	63.69	351.60	246.54
.1462	6.49	255.00	117.81	359.64	247.82	177.00	65.80	314.65	180.33	48.17
.2583	12.03	224.51	68.61	296.78	195.67	62.37	322.97	205.24	79.12	283.32
.3881	22.62	216.44	30.37	253.68	151.89	353.39	248.32	113.50	33.62	278.16
.5238	30.67	208.49	5.37	235.65	221.88	332.00	254.04	132.41	77.27	266.23
.6536	41.85	191.56	5.50	214.32	275.51	298.75	237.04	76.61	79.49	337.49
.7657	52.18	167.16	358.25	184.75	349.21	279.43	105.99	217.10	205.26	109.78
.8504	45.61	174.42	352.57	145.70	289.52	289.63	164.52	303.74	135.58	311.06
.9000	75.13	209.71	32.42	138.85	345.12	199.68	9.40	223.42	205.21	84.43

TABLE II. - CONTINUED

MEAN ANGLE = 9.00000 DEG   FREQUENCY = 98.49659 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.5092	2.8539	.3556	.2930	.1722	.0871	.0423	.0231	.0156	.0076	.0021
.0615	1.7780	2.1664	.1475	.1567	.1019	.0252	.0389	.0415	.0313	.0168	.0068
.1462	1.8778	1.3106	.1118	.1056	.0532	.0262	.0215	.0196	.0099	.0101	.0069
.2583	.9397	.8873	.0996	.0777	.0481	.0261	.0203	.0072	.0044	.0033	.0050
.3881	.6393	.6514	.0372	.0344	.0287	.0143	.0083	.0094	.0041	.0021	.0022
.5238	.4799	.5378	.0300	.0217	.0196	.0049	.0105	.0074	.0021	.0017	.0014
.6536	.3860	.4356	.0270	.0103	.0171	.0006	.0087	.0059	.0023	.0013	.0010
.7657	.2535	.2985	.0301	.0124	.0069	.0127	.0074	.0012	.0060	.0030	.0006
.8504	.1495	.2970	.0176	.0102	.0081	.0068	.0010	.0039	.0029	.0014	.0013
.9000	.1869	.2173	.0205	.0098	.0017	.0196	.0132	.0089	.0048	.0055	.0033

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	2.59	12.55	281.58	176.46	81.02	344.71	258.39	150.38	17.84	216.57
.0615	3.73	291.94	154.37	48.76	321.28	278.83	160.74	67.64	335.35	236.85
.1462	10.98	233.16	98.78	338.34	235.38	168.56	74.41	307.81	204.94	73.43
.2583	18.91	206.29	52.69	266.53	158.82	37.26	264.50	199.37	179.93	71.24
.3881	33.16	191.08	8.75	211.70	95.27	337.93	213.81	130.88	39.82	287.84
.5238	43.02	187.48	348.83	201.76	76.05	311.58	162.00	9.10	157.97	355.51
.6536	55.56	159.69	354.27	199.14	71.93	281.82	158.32	292.74	130.52	345.38
.7657	70.01	139.45	316.74	181.27	352.94	177.58	92.91	270.09	143.43	30.01
.8504	60.35	144.23	347.52	147.31	292.06	279.66	87.73	247.59	32.99	155.26
.9000	109.23	266.52	103.02	168.26	346.61	130.02	284.16	284.21	179.15	55.69

MEAN ANGLE = 11.00000 DEG   FREQUENCY = 12.56652 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.6884	1.5129	1.2515	.4876	.1597	.2223	.1127	.0247	.0554	.0502	.0418
.0615	2.2651	1.0832	.6587	.1800	.0394	.0839	.0497	.0392	.0177	.0286	.0522
.1462	1.6500	.9314	.2105	.0748	.0370	.0316	.0080	.0232	.0144	.0089	.0196
.2583	1.0959	.7180	.0829	.0246	.0257	.0354	.0106	.0130	.0117	.0035	.0199
.3881	.7607	.4608	.0839	.0277	.0230	.0287	.0145	.0120	.0169	.0110	.0010
.5238	.5689	.3505	.0677	.0211	.0117	.0209	.0150	.0078	.0113	.0087	.0035
.6536	.4682	.2880	.0365	.0231	.0033	.0141	.0154	.0065	.0043	.0034	.0014
.7657	.2770	.2412	.0425	.0293	.0072	.0115	.0143	.0073	.0026	.0007	.0002
.8504	.2044	.2258	.0566	.0326	.0125	.0188	.0175	.0097	.0030	.0024	.0043
.9000	.1984	.1940	.0445	.0213	.0096	.0115	.0120	.0074	.0034	.0020	.0010

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	16.08	53.97	323.66	315.65	248.76	149.26	135.91	68.53	293.65	144.27
.0615	13.99	47.65	295.65	312.87	225.55	98.34	307.74	196.01	243.99	131.20
.1462	6.09	40.84	303.62	249.05	176.55	61.35	157.27	60.24	81.10	14.66
.2583	4.98	18.14	285.55	253.78	157.49	51.92	112.77	356.51	118.49	350.24
.3881	9.68	27.30	288.63	259.90	173.72	87.69	65.45	341.68	246.99	174.05
.5238	13.44	18.93	260.51	245.42	162.17	62.81	34.55	325.62	241.69	194.66
.6536	12.49	335.41	198.49	132.65	140.91	33.81	308.59	275.90	238.80	200.93
.7657	9.34	283.74	175.12	102.54	110.34	3.48	246.96	171.60	82.00	235.88
.8504	4.01	260.28	160.00	104.00	73.12	340.31	227.84	112.66	229.94	145.35
.9000	3.59	261.26	169.79	125.37	71.88	334.85	215.31	126.54	42.57	309.06

TABLE II. - CONTINUED

MEAN ANGLE = 11.00000 DEG FREQUENCY = 31.27007 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.6398	1.7469	1.0579	.4114	.0984	.1100	.0406	.0403	.0454	.0148	.0274
.0615	2.3527	1.4196	.5810	.2233	.0767	.0583	.0237	.0215	.0296	.0324	.0216
.1462	1.6520	1.0166	.2032	.0845	.0878	.0671	.0349	.0386	.0476	.0317	.0191
.2583	1.0848	.7828	.1358	.0596	.0534	.0581	.0311	.0261	.0337	.0294	.0180
.3881	.7591	.5478	.1092	.0552	.0321	.0325	.0200	.0114	.0179	.0172	.0103
.5238	.5583	.4380	.0869	.0478	.0276	.0263	.0153	.0121	.0162	.0128	.0071
.6536	.4593	.3283	.0546	.0300	.0159	.0196	.0119	.0065	.0091	.0061	.0037
.7657	.2750	.2432	.0440	.0243	.0140	.0174	.0116	.0072	.0075	.0084	.0028
.8504	.2008	.2159	.0450	.0218	.0165	.0185	.0106	.0080	.0103	.0111	.0075
.9000	.1843	.1815	.0461	.0214	.0151	.0151	.0113	.0081	.0073	.0067	.0048

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	16.01	35.04	304.83	275.85	240.14	170.33	174.50	87.57	33.11	341.75
.0615	12.74	10.36	253.39	188.79	134.38	64.73	65.80	351.83	261.93	223.28
.1462	9.93	3.63	285.24	216.47	128.04	63.20	39.18	312.81	225.42	190.71
.2583	9.92	323.73	224.28	167.96	79.17	350.87	319.21	240.08	157.52	83.73
.3881	17.08	321.82	199.79	127.23	41.96	303.37	272.25	202.08	107.38	25.23
.5238	19.77	311.65	183.08	101.75	16.20	285.20	239.34	152.65	49.87	334.34
.6536	24.04	300.30	167.91	103.94	21.25	286.86	241.23	157.52	57.92	17.54
.7657	24.05	277.13	153.22	105.14	21.02	278.78	216.98	130.53	50.47	269.03
.8504	20.31	265.69	161.00	102.26	16.04	287.29	225.08	151.62	32.09	325.69
.9000	16.68	255.93	152.60	91.25	4.61	267.50	180.52	100.49	30.15	269.85

MEAN ANGLE = 11.00000 DEG FREQUENCY = 50.34338 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8000	2.0830	.7493	.2773	.0894	.1217	.0672	.0820	.0641	.0451	.0379
.0615	1.9817	1.6307	.4549	.1942	.0618	.0766	.0620	.0464	.0603	.0342	.0324
.1462	2.0853	1.1430	.2054	.0906	.0698	.0625	.0351	.0215	.0310	.0178	.0130
.2583	1.0940	.9172	.1863	.0970	.0548	.0524	.0401	.0247	.0216	.0163	.0114
.3881	.7766	.6578	.1294	.0769	.0458	.0404	.0293	.0110	.0115	.0104	.0095
.5238	.5649	.5130	.0938	.0572	.0378	.0338	.0230	.0020	.0055	.0029	.0047
.6536	.4429	.3901	.0768	.0463	.0244	.0161	.0130	.0090	.0048	.0029	.0043
.7657	.3116	.2807	.0665	.0409	.0250	.0122	.0096	.0065	.0047	.0069	.0003
.8504	.2489	.2432	.0567	.0362	.0226	.0153	.0112	.0054	.0038	.0022	.0006
.9000	.2136	.1706	.0572	.0299	.0158	.0086	.0048	.0107	.0061	.0089	.0045

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	15.89	28.37	307.22	304.41	255.19	193.97	151.86	81.02	22.24	328.52
.0615	17.00	357.31	241.43	190.01	154.36	76.23	37.72	311.12	243.10	199.87
.1462	16.29	327.80	227.31	170.81	83.56	7.69	318.02	262.75	171.66	180.21
.2583	17.00	287.40	174.88	103.02	29.18	293.68	246.30	177.37	100.46	53.27
.3881	22.17	276.70	148.09	49.31	324.23	219.20	182.91	119.68	40.02	327.66
.5238	26.81	272.55	137.40	37.95	298.69	184.41	127.70	60.20	334.97	304.77
.6536	31.12	256.23	113.13	15.13	280.28	156.90	280.91	117.04	356.55	279.49
.7657	33.50	239.01	101.18	355.44	266.97	161.50	346.60	17.94	250.74	7.76
.8504	30.02	241.24	103.09	.85	257.92	131.11	4.41	313.22	177.32	289.22
.9000	33.18	230.41	95.84	343.51	255.11	159.04	351.57	11.02	257.31	186.39

TABLE II. - CONTINUED

MEAN ANGLE = 11.00000 DEG FREQUENCY = 75.24616 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8412	2.2710	.5975	.2599	.1375	.1242	.1052	.1069	.0779	.0438	.0280
.0615	2.0650	1.8883	.3484	.1416	.0847	.1346	.0733	.0638	.0567	.0248	.0312
.1462	2.1332	1.3069	.2252	.1109	.0779	.0529	.0346	.0304	.0292	.0176	.0078
.2583	1.1390	1.0009	.2017	.1044	.0475	.0401	.0187	.0212	.0269	.0153	.0168
.3881	.8237	.7178	.1292	.0778	.0381	.0431	.0160	.0127	.0147	.0060	.0109
.5238	.6087	.5689	.0948	.0595	.0295	.0379	.0145	.0115	.0102	.0079	.0053
.6536	.4802	.4279	.0720	.0448	.0233	.0296	.0117	.0091	.0060	.0051	.0060
.7657	.3209	.2888	.0614	.0320	.0215	.0127	.0076	.0113	.0110	.0138	.0067
.8504	.2576	.2758	.0521	.0282	.0229	.0231	.0098	.0063	.0085	.0059	.0056
.9000	.2097	.1516	.0508	.0307	.0151	.0186	.0054	.0144	.0174	.0143	.0056

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	8.75	22.81	310.02	270.70	202.54	160.15	82.49	352.71	274.63	196.30
.0615	10.67	330.95	216.09	185.40	120.14	28.34	324.54	244.18	174.66	133.91
.1462	12.76	286.81	175.34	111.80	20.25	292.64	251.19	164.66	74.34	39.49
.2583	12.66	242.10	113.32	33.10	289.49	235.77	198.74	95.32	11.89	300.48
.3881	18.94	220.51	73.32	323.43	236.97	147.80	95.05	3.36	264.69	207.36
.5238	24.82	210.55	57.39	303.74	224.78	112.51	30.38	293.06	171.73	118.52
.6536	34.10	202.85	46.09	304.74	224.19	94.65	348.74	264.78	154.63	105.69
.7657	41.14	188.07	42.93	300.83	269.25	44.41	357.58	235.51	153.20	17.79
.8504	35.81	184.00	38.60	292.47	185.15	10.30	329.23	220.10	121.34	40.16
.9000	59.74	195.33	45.17	269.18	327.97	76.25	323.32	202.23	133.48	331.54

MEAN ANGLE = 11.00000 DEG FREQUENCY = 98.56195 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8534	2.3831	.5715	.3023	.1584	.1215	.0989	.0814	.0487	.0162	.0044
.0615	2.0953	2.0435	.3065	.1436	.1133	.1241	.0784	.0483	.0362	.0252	.0348
.1462	2.1649	1.3988	.2127	.1062	.0638	.0627	.0421	.0399	.0272	.0129	.0131
.2583	1.1764	1.0438	.2228	.1141	.0352	.0420	.0230	.0156	.0213	.0227	.0252
.3881	.8492	.7369	.1358	.0822	.0400	.0324	.0266	.0180	.0110	.0046	.0099
.5238	.6336	.5912	.1015	.0643	.0439	.0302	.0202	.0101	.0063	.0046	.0072
.6536	.4983	.4581	.0782	.0417	.0364	.0220	.0157	.0085	.0061	.0027	.0042
.7657	.3225	.2946	.0722	.0295	.0305	.0147	.0105	.0119	.0109	.0071	.0072
.8504	.2590	.3026	.0504	.0269	.0249	.0212	.0155	.0042	.0085	.0077	.0050
.9000	.2013	.1809	.0295	.0164	.0217	.0181	.0085	.0186	.0083	.0068	.0078

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	6.50	26.52	311.14	251.86	192.43	118.73	32.96	294.78	187.57	350.79
.0615	8.89	320.74	204.05	161.52	87.14	353.02	296.90	219.69	185.94	112.21
.1462	12.34	263.07	145.11	100.43	8.83	290.31	210.70	117.46	36.63	327.56
.2583	12.33	212.17	81.76	353.48	280.74	189.22	141.32	59.42	332.15	230.04
.3881	22.26	187.72	41.15	280.90	210.97	100.77	14.96	265.27	231.28	141.59
.5238	30.63	176.56	27.47	262.27	157.06	36.06	302.14	185.78	186.44	50.93
.6536	42.30	163.43	19.82	259.82	139.63	16.30	281.11	174.62	97.38	12.66
.7657	54.18	145.95	358.98	248.01	79.07	12.04	261.68	184.07	64.03	303.35
.8504	46.75	146.47	3.30	236.90	95.13	314.49	217.04	163.44	46.57	264.51
.9000	101.15	189.84	44.81	235.91	28.74	16.43	224.93	150.83	14.61	236.40

TABLE II. - CONTINUED

MEAN ANGLE = 12.00000 DEG FREQUENCY = 12.56210 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.7088	1.0541	1.3935	.3306	.3392	.2170	.0467	.1146	.0604	.0147	.0247
.0615	2.2951	.8430	.6891	.0661	.1642	.1134	.0211	.0296	.0422	.0307	.0048
.1462	1.7288	.0144	.2576	.0624	.0549	.0469	.0104	.0098	.0126	.0149	.0170
.2583	1.1730	.6873	.0939	.0387	.0533	.0341	.0115	.0213	.0044	.0158	.0140
.3881	.8219	.4431	.0843	.0293	.0328	.0145	.0134	.0237	.0107	.0077	.0104
.5238	.5908	.3433	.0651	.0100	.0194	.0132	.0055	.0172	.0117	.0109	.0100
.6536	.4964	.2864	.0403	.0162	.0092	.0177	.0078	.0092	.0085	.0085	.0066
.7657	.3422	.2326	.0408	.0185	.0150	.0209	.0084	.0067	.0060	.0042	.0047
.8504	.2591	.2190	.0422	.0249	.0250	.0278	.0114	.0077	.0092	.0049	.0062
.9000	.2136	.1818	.0303	.0124	.0151	.0138	.0030	.0057	.0060	.0034	.0023

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	31.64	58.25	352.25	352.03	264.36	274.32	200.93	88.33	201.38	52.94
.0615	24.73	48.47	332.74	336.45	228.74	60.81	198.59	38.58	260.32	22.47
.1462	10.24	42.97	323.41	306.86	203.52	94.35	188.28	187.79	124.60	101.18
.2583	5.36	34.19	333.32	257.32	137.47	285.30	139.13	71.45	82.78	2.87
.3881	10.18	37.83	329.64	261.39	136.20	256.00	130.84	31.54	60.83	338.06
.5238	14.45	21.87	295.38	274.80	157.05	248.34	129.58	49.94	11.88	297.05
.6536	13.98	337.29	199.65	246.99	125.73	343.12	148.90	59.02	10.53	289.81
.7657	11.99	306.09	210.29	205.62	107.58	348.40	117.72	7.56	324.36	249.14
.8504	10.63	293.47	229.61	188.58	100.96	2.33	72.39	326.91	261.42	208.00
.9000	5.82	280.25	228.70	185.69	91.13	9.41	56.20	298.34	208.41	152.33

MEAN ANGLE = 12.00000 DEG FREQUENCY = 31.00715 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.7779	1.4607	1.1159	.3169	.1508	.0969	.0449	.0682	.0358	.0373	.0280
.0615	2.4111	1.2861	.6493	.1991	.0999	.0683	.0305	.0299	.0260	.0262	.0395
.1462	1.7214	.9323	.2831	.1303	.0883	.0436	.0490	.0554	.0299	.0328	.0238
.2583	1.1391	.7602	.1765	.0785	.0686	.0517	.0256	.0327	.0260	.0193	.0184
.3881	.8225	.5554	.1235	.0479	.0290	.0297	.0219	.0210	.0161	.0139	.0139
.5238	.5998	.4529	.0966	.0411	.0235	.0222	.0146	.0161	.0113	.0067	.0088
.6536	.5110	.3470	.0675	.0289	.0176	.0194	.0110	.0120	.0087	.0052	.0068
.7657	.3324	.2631	.0573	.0247	.0137	.0144	.0050	.0054	.0071	.0028	.0072
.8504	.2446	.2396	.0523	.0251	.0160	.0119	.0071	.0038	.0042	.0042	.0095
.9000	.2133	.1981	.0539	.0196	.0134	.0108	.0058	.0049	.0019	.0032	.0036

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	25.46	42.54	328.34	327.44	267.64	283.54	223.53	171.45	143.93	58.47
.0615	23.12	15.32	273.86	241.94	177.03	154.98	113.85	61.58	30.03	334.02
.1462	18.36	11.92	294.79	223.72	166.21	146.84	71.01	357.62	331.07	270.15
.2583	16.95	337.18	248.09	187.23	102.47	65.12	.77	284.80	243.03	173.51
.3881	21.74	324.10	212.60	170.90	91.18	24.38	318.89	257.99	215.43	124.14
.5238	23.56	310.91	190.96	137.00	58.71	358.22	290.57	217.61	166.95	90.64
.6536	26.63	297.87	180.17	133.96	61.01	359.02	301.58	241.14	194.87	96.61
.7657	24.61	271.51	155.61	116.07	41.70	324.99	284.44	224.21	109.55	119.55
.8504	19.54	263.54	163.06	112.86	30.01	325.43	270.79	202.68	165.25	106.09
.9000	16.22	253.37	156.88	106.14	26.94	307.84	238.53	197.76	111.58	93.40

TABLE II. - CONTINUED

MEAN ANGLE = 12.00000 DEG FREQUENCY = 49.34153 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8092	1.7028	.9762	.2605	.0859	.1030	.0778	.0836	.0624	.0478	.0306
.0615	1.9950	1.5482	.5718	.2031	.0631	.0406	.0478	.0670	.0270	.0344	.0236
.1462	2.1148	1.1156	.2284	.0892	.0794	.0381	.0530	.0463	.0236	.0226	.0313
.2583	1.1425	.9109	.1635	.0701	.0771	.0644	.0249	.0366	.0216	.0171	.0147
.3881	.8438	.6637	.1276	.0610	.0446	.0426	.0144	.0248	.0171	.0169	.0124
.5238	.6138	.5286	.1059	.0584	.0393	.0307	.0141	.0192	.0088	.0130	.0110
.6536	.4694	.4192	.0950	.0562	.0366	.0271	.0140	.0090	.0024	.0072	.0058
.7657	.3091	.3046	.0809	.0464	.0345	.0215	.0148	.0013	.0047	.0023	.0076
.8504	.2789	.2680	.0727	.0391	.0332	.0149	.0100	.0060	.0055	.0072	.0099
.9000	.2094	.1903	.0740	.0382	.0268	.0122	.0084	.0071	.0078	.0068	.0079

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	33.09	40.48	321.97	357.74	317.34	277.65	217.91	185.14	120.44	104.69
.0615	28.91	4.33	253.67	222.87	184.17	182.77	116.62	29.53	26.83	304.54
.1462	23.35	344.25	267.44	207.11	143.00	121.69	36.06	320.79	343.78	254.64
.2583	21.75	305.55	225.17	165.76	70.92	10.86	313.58	237.42	195.95	124.28
.3881	27.26	292.32	179.15	107.05	10.90	286.21	275.86	197.32	140.23	55.39
.5238	31.96	287.38	169.15	82.06	351.88	272.93	246.61	156.56	122.27	12.63
.6536	35.03	273.64	153.97	66.83	334.65	241.82	239.58	114.24	141.86	.54
.7657	36.43	261.30	147.12	59.30	330.62	236.65	12.62	89.81	112.79	334.58
.8504	33.30	257.35	149.33	52.03	304.87	221.56	221.58	105.40	79.03	310.84
.9000	33.09	249.83	135.51	34.24	317.32	236.28	19.14	114.12	348.90	275.09

MEAN ANGLE = 12.00000 DEG FREQUENCY = 74.58685 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.9200	2.0375	.7300	.1977	.1369	.1038	.0979	.0829	.0472	.0400	.0269
.0615	2.1231	1.8775	.4246	.1315	.0836	.1257	.0686	.0625	.0322	.0390	.0330
.1462	2.1510	1.3025	.2321	.0951	.0985	.0532	.0436	.0492	.0269	.0189	.0234
.2583	1.1781	1.0502	.2226	.0965	.0515	.0378	.0172	.0267	.0169	.0137	.0083
.3881	.8804	.7758	.1607	.0867	.0485	.0469	.0122	.0200	.0114	.0100	.0126
.5238	.6566	.6175	.1210	.0677	.0410	.0419	.0130	.0159	.0082	.0055	.0080
.6536	.5062	.4711	.0959	.0591	.0336	.0334	.0112	.0089	.0053	.0053	.0056
.7657	.3304	.3197	.0895	.0490	.0315	.0154	.0090	.0113	.0053	.0088	.0012
.8504	.2906	.3010	.0828	.0410	.0269	.0224	.0064	.0077	.0015	.0035	.0016
.9000	.2150	.1583	.0745	.0438	.0255	.0200	.0117	.0134	.0089	.0097	.0013

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	21.50	32.17	329.17	330.92	262.04	227.40	155.99	95.86	43.19	308.97
.0615	19.33	339.85	231.22	234.82	166.33	110.68	41.00	343.80	319.51	232.47
.1462	20.59	309.51	224.68	163.78	87.35	36.82	318.37	242.00	196.62	121.22
.2583	20.15	265.10	154.43	100.62	350.25	332.12	264.92	173.34	145.62	58.38
.3881	24.50	242.68	112.42	19.06	275.80	229.06	172.68	80.41	63.80	316.74
.5238	28.82	229.70	96.26	355.14	259.20	194.59	117.00	26.26	344.61	232.43
.6536	35.06	218.83	82.22	338.77	250.24	181.22	74.83	43.70	306.22	166.38
.7657	37.86	202.47	66.76	317.92	289.27	149.81	45.27	282.84	217.84	104.04
.8504	33.17	200.09	70.41	326.58	229.37	124.16	32.35	320.77	195.93	285.39
.9000	50.08	205.27	67.24	304.62	322.80	111.88	347.17	241.74	199.76	255.86

TABLE II. - CONTINUED

MEAN ANGLE = 12.00000 DEG FREQUENCY = 98.71777 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.9599	2.1911	.6569	.2634	.1207	.1046	.1086	.0728	.0318	.0152	.0087
.0615	2.1804	2.0840	.3363	.0966	.1263	.1090	.0604	.0619	.0310	.0331	.0183
.1462	2.2046	1.4237	.2077	.0868	.1053	.0654	.0377	.0479	.0289	.0144	.0077
.2583	1.2325	1.1119	.2339	.1075	.0584	.0432	.0168	.0266	.0188	.0173	.0138
.3881	.9210	.8048	.1657	.0853	.0456	.0318	.0135	.0185	.0133	.0131	.0071
.5238	.6961	.6382	.1299	.0706	.0467	.0330	.0159	.0115	.0065	.0079	.0060
.6536	.5343	.4883	.0983	.0521	.0380	.0257	.0111	.0054	.0057	.0061	.0065
.7657	.3386	.3111	.0946	.0407	.0442	.0167	.0147	.0095	.0121	.0108	.0087
.8504	.2893	.3157	.0741	.0436	.0378	.0286	.0143	.0041	.0083	.0090	.0063
.9000	.2110	.1580	.0445	.0269	.0325	.0120	.0116	.0208	.0137	.0138	.0110

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	13.68	32.13	326.67	291.90	259.14	182.81	89.70	14.56	308.97	177.99
.0615	12.90	323.29	225.07	199.71	119.40	69.16	6.06	299.91	244.93	161.14
.1462	15.98	278.22	188.45	127.54	27.33	351.44	266.25	171.71	90.27	63.51
.2583	14.97	227.24	117.15	55.21	317.85	269.72	203.85	129.17	61.00	336.43
.3881	21.23	198.66	67.59	332.24	234.38	171.72	111.66	36.13	297.64	194.52
.5238	27.50	181.12	46.65	298.17	187.96	100.05	28.77	307.30	224.16	137.01
.6536	37.20	165.81	33.11	280.14	155.80	57.14	.20	265.78	183.18	79.96
.7657	46.02	153.48	21.81	265.85	119.26	43.52	284.99	240.78	121.34	7.93
.8504	39.98	155.15	21.45	255.34	121.34	355.20	278.45	216.69	96.76	314.41
.9000	91.30	180.34	47.66	244.78	52.66	55.01	257.40	200.34	87.67	299.96

MEAN ANGLE = 14.00000 DEG FREQUENCY = 12.52333 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.4859	.9509	1.2393	.3907	.2815	.1934	.1328	.0707	.0704	.0180	.0299
.0615	2.2456	.7474	.6064	.1962	.1469	.0793	.0805	.0083	.0346	.0254	.0102
.1462	1.5873	.6166	.3806	.0236	.0682	.0308	.0363	.0122	.0176	.0156	.0236
.2583	1.1379	.5099	.2306	.0172	.0338	.0087	.0172	.0133	.0094	.0152	.0144
.3881	.8867	.3796	.0967	.0199	.0204	.0219	.0117	.0204	.0173	.0120	.0152
.5238	.6777	.3275	.0445	.0196	.0131	.0160	.0145	.0151	.0144	.0064	.0100
.6536	.6213	.2822	.0181	.0240	.0267	.0070	.0132	.0080	.0141	.0020	.0031
.7657	.4442	.2433	.0064	.0301	.0265	.0069	.0149	.0052	.0157	.0090	.0041
.8504	.3417	.2383	.0099	.0311	.0296	.0079	.0123	.0034	.0132	.0077	.0022
.9000	.2782	.2147	.0144	.0309	.0173	.0091	.0104	.0066	.0138	.0067	.0015

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	95.94	62.59	81.30	18.81	34.19	317.71	339.17	247.47	358.49	214.96
.0615	76.29	42.27	87.11	330.83	52.90	295.96	89.06	219.85	62.05	200.61
.1462	51.73	25.17	94.67	309.36	76.34	289.01	340.35	268.50	287.12	238.98
.2583	37.06	14.78	294.52	291.64	334.71	244.66	259.12	168.91	244.69	165.72
.3881	26.17	21.73	45.79	321.44	313.25	195.90	288.55	178.48	212.49	123.09
.5238	18.84	23.18	28.41	279.66	291.25	155.42	286.35	152.32	182.92	84.80
.6536	13.92	1.33	345.61	235.74	223.42	144.02	271.09	123.35	24.10	8.63
.7657	6.30	268.51	328.77	218.29	242.98	147.16	234.73	96.41	335.83	254.63
.8504	3.16	262.45	311.40	213.52	226.56	142.00	216.78	84.86	335.91	322.72
.9000	355.59	204.33	313.62	195.30	255.29	147.27	197.10	77.95	319.37	316.46

TABLE II. - CONTINUED

MEAN ANGLE = 14.00000 DEG FREQUENCY = 75.17133 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.7686	1.7881	.7980	.1782	.1438	.1247	.0753	.0619	.0742	.0537	.0348
.0615	2.0719	1.8188	.4635	.0974	.1466	.1131	.1009	.0517	.0514	.0419	.0363
.1462	2.1680	1.3671	.2804	.0898	.0966	.0715	.0652	.0328	.0227	.0209	.0206
.2583	1.2646	1.1580	.2612	.0987	.0783	.0336	.0332	.0234	.0192	.0152	.0194
.3881	.9338	.8707	.1892	.0736	.0518	.0275	.0259	.0228	.0183	.0112	.0128
.5238	.7269	.6938	.1516	.0650	.0436	.0356	.0234	.0160	.0122	.0130	.0131
.6536	.5962	.5307	.1253	.0599	.0322	.0275	.0175	.0093	.0149	.0139	.0089
.7657	.4747	.3708	.1088	.0575	.0308	.0362	.0229	.0089	.0064	.0044	.0037
.8504	.3910	.3577	.1144	.0630	.0343	.0314	.0227	.0116	.0097	.0062	.0023
.9000	.3280	.1856	.0993	.0568	.0293	.0369	.0217	.0124	.0085	.0102	.0049

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	38.76	40.26	3.59	14.21	325.22	267.81	260.88	205.75	142.03	81.05
.0615	31.53	347.72	298.32	260.40	206.38	161.56	106.74	76.51	28.00	349.33
.1462	29.45	314.25	259.24	200.59	161.70	88.39	24.18	1.24	306.69	255.00
.2583	23.81	271.61	192.27	135.41	57.09	14.37	317.86	250.39	228.39	161.02
.3881	24.23	241.72	139.02	64.14	328.38	301.93	237.82	158.77	127.90	50.93
.5238	25.14	223.51	115.91	28.79	303.98	240.75	193.42	111.97	101.96	348.95
.6536	27.72	209.27	100.71	5.79	288.47	231.49	188.84	130.81	54.75	306.46
.7657	28.77	204.71	96.89	359.12	308.02	202.22	116.42	100.06	307.06	276.33
.8504	22.22	204.11	92.15	346.54	271.53	184.48	106.57	43.15	301.09	251.94
.9000	31.58	205.81	80.20	340.03	310.09	172.71	47.13	244.52	197.21	340.77

MEAN ANGLE = 14.00000 DEG FREQUENCY = 98.80767 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8363	1.9530	.7030	.2543	.1252	.1250	.1066	.0768	.0504	.0268	.0111
.0615	2.1474	2.0458	.3640	.1420	.1680	.1075	.0854	.0756	.0617	.0296	.0172
.1462	2.2390	1.5374	.2531	.0882	.0991	.0581	.0383	.0378	.0343	.0246	.0216
.2583	1.3338	1.2596	.2620	.0927	.0800	.0502	.0307	.0336	.0318	.0247	.0145
.3881	.9963	.9322	.2174	.0805	.0580	.0390	.0250	.0254	.0200	.0189	.0150
.5238	.7778	.7183	.1705	.0735	.0427	.0265	.0154	.0231	.0092	.0131	.0078
.6536	.6423	.5464	.1462	.0761	.0382	.0292	.0140	.0160	.0058	.0131	.0060
.7657	.5153	.3429	.1438	.0779	.0465	.0265	.0260	.0102	.0035	.0092	.0061
.8504	.4100	.3362	.1231	.0782	.0433	.0265	.0203	.0123	.0041	.0124	.0063
.9000	.3533	.1022	.0869	.0625	.0385	.0183	.0310	.0181	.0081	.0170	.0071

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	24.97	41.35	355.20	345.15	312.94	245.11	184.79	120.28	40.62	270.97
.0615	21.58	337.08	299.67	224.87	165.02	129.12	70.25	5.42	295.36	270.53
.1462	22.02	284.23	227.45	153.51	109.53	38.93	21.45	295.49	248.59	175.05
.2583	15.66	232.78	157.22	98.21	27.38	310.12	276.38	188.89	129.79	44.68
.3881	16.08	197.99	97.43	25.02	292.04	222.67	180.50	88.26	33.35	272.37
.5238	18.71	178.17	71.11	324.03	245.85	194.43	119.52	28.75	331.03	224.42
.6536	24.20	168.65	61.78	304.69	222.45	153.25	75.95	23.07	285.28	157.61
.7657	24.27	159.48	42.33	277.58	216.77	99.82	343.19	265.27	232.37	125.91
.8504	21.76	153.97	26.78	253.09	186.21	72.60	332.48	347.93	197.38	68.38
.9000	62.34	168.92	31.68	251.55	199.52	61.09	254.69	285.13	154.19	29.71

TABLE II. - CONTINUED

MEAN ANGLE = 14.00000 DEG FREQUENCY = 30.91365 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.4535	1.2755	1.1019	.3454	.1629	.0921	.0142	.0623	.0373	.0372	.0320
.0615	2.3474	1.1954	.6224	.2033	.1597	.0641	.0600	.0171	.0295	.0346	.0319
.1462	1.6535	.8708	.3217	.1127	.0566	.0576	.0399	.0401	.0325	.0392	.0267
.2583	1.1779	.7326	.2084	.1040	.0666	.0497	.0417	.0302	.0328	.0199	.0206
.3881	.8986	.5708	.1130	.0562	.0426	.0323	.0297	.0190	.0271	.0136	.0153
.5238	.6762	.4838	.0764	.0358	.0275	.0268	.0219	.0169	.0242	.0044	.0081
.6536	.6322	.3779	.0504	.0291	.0283	.0189	.0175	.0111	.0160	.0043	.0030
.7657	.4542	.2977	.0527	.0291	.0235	.0123	.0118	.0117	.0127	.0016	.0088
.8504	.3395	.2715	.0502	.0357	.0243	.0129	.0101	.0095	.0094	.0115	.0080
.9000	.2825	.2361	.0508	.0362	.0202	.0112	.0105	.0062	.0082	.0046	.0097

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	74.68	53.07	32.71	358.48	347.49	330.67	353.08	305.03	296.42	235.81
.0615	56.33	19.84	2.44	281.72	284.20	205.79	230.88	174.14	160.32	120.72
.1462	44.66	13.89	342.80	274.15	281.78	212.87	219.09	153.57	123.86	83.15
.2583	34.11	351.50	305.75	225.78	217.34	135.60	135.07	59.12	48.05	334.54
.3881	31.18	330.94	297.61	203.56	190.97	92.62	107.48	11.91	2.91	271.10
.5238	26.70	305.42	278.07	174.95	172.30	53.37	95.27	332.06	277.91	222.99
.6536	26.15	288.69	274.85	168.65	167.84	54.22	96.63	324.48	94.79	278.93
.7657	20.60	268.92	243.31	142.36	147.70	50.83	59.05	300.95	92.48	221.71
.8504	17.50	273.34	235.02	151.03	134.81	48.77	41.05	307.34	279.89	208.40
.9000	9.58	268.64	220.21	121.02	123.12	24.19	17.39	266.62	75.92	209.83

MEAN ANGLE = 14.00000 DEG FREQUENCY = 49.21255 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.7085	1.4068	1.0459	.3149	.0715	.0719	.0675	.0711	.0747	.0521	.0287
.0615	1.9621	1.4200	.5854	.1547	.1419	.0597	.0504	.0389	.0442	.0400	.0335
.1462	2.0925	1.1075	.3203	.1016	.0630	.0524	.0543	.0359	.0387	.0270	.0291
.2583	1.1975	.9423	.2293	.0946	.0687	.0370	.0382	.0258	.0235	.0048	.0160
.3881	.9065	.7336	.1629	.0670	.0533	.0264	.0281	.0252	.0165	.0023	.0087
.5238	.7048	.5940	.1227	.0499	.0374	.0205	.0181	.0230	.0103	.0105	.0111
.6536	.5607	.4627	.0927	.0397	.0257	.0098	.0113	.0206	.0057	.0101	.0067
.7657	.4597	.3512	.0897	.0438	.0268	.0151	.0136	.0137	.0054	.0122	.0072
.8504	.3913	.3300	.0929	.0541	.0281	.0115	.0111	.0160	.0055	.0039	.0051
.9000	.3370	.2397	.0895	.0512	.0256	.0122	.0110	.0076	.0033	.0179	.0109

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	57.69	51.63	2.05	337.90	16.64	348.04	305.76	269.33	215.22	187.85
.0615	46.58	12.75	321.10	271.21	241.03	196.75	212.46	156.66	113.46	64.30
.1462	38.41	346.45	283.96	234.97	228.76	162.17	143.36	73.39	51.35	347.76
.2583	32.27	317.69	253.04	186.72	153.12	89.09	40.52	332.50	356.17	260.31
.3881	30.39	293.51	219.42	141.37	86.20	27.47	328.86	255.78	224.98	201.35
.5238	29.41	275.80	196.97	114.17	66.83	358.59	319.97	231.86	227.12	140.57
.6536	29.77	258.97	183.12	87.10	75.58	1.50	314.56	204.34	216.40	136.89
.7657	27.35	247.60	164.70	72.05	48.86	322.08	315.75	152.19	211.74	105.70
.8504	21.31	250.51	163.40	61.06	39.85	306.16	280.58	165.35	185.15	151.47
.9000	18.28	245.56	148.87	43.37	31.30	266.15	3.34	.94	213.04	98.42

TABLE II. - CONTINUED

MEAN ANGLE = 16.00000 DEG FREQUENCY = 12.52287 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.1462	1.4529	.9007	.6407	.1742	.2050	.1514	.0914	.0980	.0570	.0436
.0615	2.6299	.8792	.3901	.3445	.0123	.1299	.0312	.0775	.0189	.0449	.0092
.1462	1.7720	.6128	.3102	.1504	.0623	.0393	.0158	.0302	.0246	.0159	.0260
.2583	1.3122	.4572	.1973	.0683	.0370	.0145	.0128	.0137	.0209	.0101	.0196
.3881	1.0358	.3384	.0935	.0283	.0116	.0115	.0246	.0168	.0209	.0134	.0174
.5238	.7115	.2993	.0558	.0137	.0069	.0125	.0214	.0177	.0108	.0053	.0164
.6536	.6403	.2663	.0313	.0219	.0043	.0167	.0087	.0140	.0033	.0045	.0058
.7657	.4005	.2443	.0180	.0280	.0060	.0159	.0085	.0102	.0053	.0064	.0055
.8504	.2588	.2372	.0325	.0336	.0057	.0198	.0018	.0138	.0058	.0096	.0015
.9000	.1697	.2252	.0096	.0280	.0079	.0100	.0120	.0096	.0061	.0055	.0056

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	130.63	76.99	115.00	93.44	79.52	96.94	20.21	70.54	319.40	54.52
.0615	102.47	56.21	92.36	285.93	54.31	115.85	350.99	47.93	279.58	351.20
.1462	75.34	40.40	69.46	304.95	37.71	114.30	11.41	43.21	349.15	11.57
.2583	55.04	33.18	49.34	309.58	338.38	60.11	326.92	354.99	272.76	312.30
.3881	30.10	39.50	60.87	39.51	329.02	44.79	289.41	339.49	229.87	296.80
.5238	27.35	37.50	7.59	80.46	279.57	38.97	262.81	324.99	197.73	269.26
.6536	20.71	24.52	318.85	194.93	268.91	54.81	245.25	317.84	172.75	276.10
.7657	12.79	349.53	300.49	186.21	254.59	51.87	217.13	331.84	142.47	274.55
.8504	8.09	319.45	297.88	253.78	251.66	30.09	204.80	348.96	149.50	20.81
.9000	1.32	335.79	278.54	86.25	250.15	4.68	213.44	306.02	149.35	257.92

MEAN ANGLE = 16.00000 DEG FREQUENCY = 30.98587 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.1329	1.5241	.8694	.4400	.1494	.0827	.0337	.0333	.0462	.0433	.0342
.0615	2.7027	1.2712	.4579	.3508	.1078	.1067	.0322	.0428	.0289	.0372	.0214
.1462	1.7356	.9087	.2483	.1879	.0576	.0679	.0413	.0366	.0432	.0278	.0299
.2583	1.3107	.7615	.1838	.1460	.0553	.0636	.0322	.0305	.0282	.0093	.0263
.3881	1.0405	.6010	.1036	.0950	.0336	.0475	.0136	.0219	.0125	.0103	.0131
.5238	.7128	.5239	.0721	.0713	.0223	.0403	.0103	.0199	.0070	.0057	.0059
.6536	.6556	.4264	.0561	.0543	.0186	.0258	.0094	.0114	.0080	.0052	.0087
.7657	.4090	.3581	.0647	.0537	.0218	.0214	.0066	.0088	.0070	.0103	.0044
.8504	.2739	.3318	.0759	.0573	.0276	.0239	.0034	.0035	.0042	.0083	.0035
.9000	.1790	.2867	.0696	.0512	.0271	.0209	.0052	.0025	.0038	.0073	.0066

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	101.80	74.65	75.80	57.92	41.71	92.63	84.45	84.09	51.16	45.97
.0615	75.66	44.01	35.37	342.03	328.55	307.62	295.03	305.75	292.73	279.68
.1462	63.67	37.58	24.19	343.92	322.20	327.22	295.38	286.18	274.93	228.13
.2583	50.17	14.25	344.09	296.59	258.01	257.48	199.92	206.40	180.05	139.53
.3881	42.97	356.54	324.14	262.96	223.28	199.79	150.72	146.38	66.65	82.37
.5238	35.85	329.23	300.54	240.44	198.24	177.52	115.25	87.93	22.36	44.27
.6536	32.17	310.21	288.04	236.53	191.56	233.36	133.47	137.91	78.90	67.22
.7657	24.79	291.82	262.82	202.64	150.04	199.27	104.71	96.83	39.07	341.65
.8504	20.59	294.82	256.29	204.99	143.97	134.57	71.36	133.93	172.02	24.69
.9000	13.40	294.89	244.09	194.93	122.02	101.41	39.76	37.39	44.27	328.31

TABLE II. - CONTINUED

MEAN ANGLE = 16.00000 DEG FREQUENCY = 49.64088 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.0809	1.4562	1.0066	.3625	.0949	.0196	.0894	.0575	.0530	.0510	.0405
.0615	2.2371	1.5055	.4713	.2779	.1118	.0886	.0306	.0539	.0346	.0301	.0269
.1462	2.2643	1.1814	.2686	.1568	.0504	.0708	.0330	.0548	.0335	.0292	.0279
.2583	1.4550	1.0352	.2290	.1616	.0695	.0833	.0217	.0393	.0143	.0136	.0127
.3881	1.0852	.8136	.1392	.1133	.0372	.0546	.0109	.0260	.0058	.0099	.0063
.5238	.7618	.6561	.1005	.0939	.0276	.0350	.0103	.0121	.0118	.0052	.0106
.6536	.6452	.5313	.0883	.0885	.0207	.0312	.0100	.0164	.0080	.0061	.0031
.7657	.4466	.4262	.1017	.0814	.0209	.0330	.0029	.0172	.0161	.0099	.0046
.8504	.3566	.3944	.1064	.0775	.0166	.0364	.0050	.0101	.0155	.0100	.0065
.9000	.2244	.2963	.1025	.0638	.0196	.0295	.0114	.0179	.0086	.0116	.0056

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	81.85	74.81	41.70	39.56	27.00	96.03	55.29	39.11	9.28	332.71
.0615	60.98	34.67	12.67	312.71	308.05	307.17	265.60	263.13	235.00	217.58
.1462	50.85	11.10	334.82	303.93	268.27	279.09	220.70	213.42	162.08	135.70
.2583	41.57	343.75	292.03	248.43	191.68	170.54	125.69	89.20	61.91	23.41
.3881	35.89	316.82	259.84	191.55	142.09	157.96	61.03	48.29	10.34	317.00
.5238	32.86	301.54	236.44	148.06	103.34	166.00	353.53	79.51	13.03	346.97
.6536	28.48	282.66	217.07	131.60	97.08	94.27	322.04	339.36	162.69	16.85
.7657	24.50	269.64	198.68	131.33	80.09	353.41	7.52	308.15	214.43	123.40
.8504	19.24	267.58	187.04	128.88	54.69	314.21	.61	300.39	218.34	173.02
.9000	17.16	265.64	177.81	120.28	47.65	264.09	14.14	285.98	235.52	143.88

MEAN ANGLE = 16.00000 DEG FREQUENCY = 73.97887 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.0587	1.7081	.8564	.2268	.1241	.0717	.0583	.0867	.0828	.0545	.0398
.0615	2.2909	1.8489	.4291	.1929	.1083	.1094	.0734	.0780	.0404	.0377	.0337
.1462	2.3052	1.4566	.2580	.1461	.0637	.0946	.0429	.0453	.0339	.0284	.0204
.2583	1.5000	1.2764	.2494	.1659	.0617	.0581	.0360	.0278	.0211	.0132	.0184
.3881	1.1334	1.0131	.2021	.1484	.0529	.0351	.0277	.0265	.0254	.0216	.0101
.5238	.8193	.8248	.1728	.1376	.0479	.0406	.0185	.0146	.0177	.0078	.0144
.6536	.6822	.6436	.1468	.1147	.0290	.0375	.0155	.0114	.0148	.0028	.0109
.7657	.4795	.4814	.1582	.1180	.0394	.0492	.0152	.0059	.0175	.0079	.0123
.8504	.3912	.4591	.1605	.1207	.0461	.0429	.0077	.0094	.0105	.0076	.0107
.9000	.2564	.2538	.1483	.1034	.0476	.0518	.0130	.0014	.0169	.0102	.0150

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	59.05	56.52	31.31	49.98	24.63	26.16	355.48	303.10	258.88	208.04
.0615	44.20	9.10	344.01	297.02	268.62	245.81	207.01	163.73	142.53	118.91
.1462	38.57	337.08	294.09	248.89	213.17	180.97	134.19	109.15	54.50	39.30
.2583	30.99	300.36	238.25	180.85	145.57	101.87	31.11	45.81	325.12	311.64
.3881	26.27	266.65	190.08	96.58	60.69	29.99	313.26	298.88	185.25	191.44
.5238	23.04	248.65	162.65	62.84	357.52	335.97	242.46	247.33	130.83	145.84
.6536	21.51	234.27	142.49	54.95	334.60	313.39	246.05	198.72	141.19	104.12
.7657	14.87	222.83	122.10	32.75	317.42	273.88	224.58	184.11	165.07	61.73
.8504	10.34	222.45	116.80	10.90	280.73	252.67	190.23	174.80	97.16	62.59
.9000	10.12	224.77	103.34	19.10	298.62	227.82	165.29	197.01	152.07	26.70

TABLE II. - CONTINUED

MEAN ANGLE = 16.00000 DEG FREQUENCY = 98.56314 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.0598	1.7226	.9184	.2949	.0911	.0869	.1141	.1120	.0613	.0249	.0149
.0615	2.4248	2.1045	.3858	.2209	.1406	.0982	.0658	.0538	.0422	.0387	.0241
.1462	2.4436	1.6935	.2462	.1416	.0703	.0803	.0352	.0483	.0336	.0280	.0191
.2583	1.6127	1.4388	.2569	.1445	.0588	.0682	.0359	.0324	.0359	.0226	.0278
.3881	1.2086	1.1025	.2384	.1447	.0411	.0385	.0192	.0198	.0205	.0140	.0127
.5238	.8633	.8786	.2081	.1458	.0383	.0294	.0235	.0186	.0161	.0106	.0110
.6536	.7240	.6674	.1798	.1310	.0355	.0300	.0121	.0084	.0179	.0112	.0084
.7657	.4992	.4371	.1795	.1257	.0418	.0259	.0091	.0044	.0176	.0048	.0159
.8504	.3927	.4329	.1771	.1217	.0420	.0262	.0008	.0057	.0189	.0059	.0168
.9000	.2631	.1198	.1336	.0947	.0401	.0222	.0156	.0170	.0223	.0082	.0130

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	47.78	55.12	8.03	22.40	31.60	358.64	291.75	225.21	189.41	150.48
.0615	33.22	.75	332.49	269.31	234.21	207.08	176.62	144.82	99.10	67.96
.1462	29.23	307.09	270.75	205.85	169.65	153.01	98.96	65.65	12.12	325.85
.2583	21.39	259.64	199.17	149.88	99.95	66.24	2.08	331.31	264.08	215.87
.3881	17.90	222.47	134.21	45.41	1.43	339.61	248.81	229.03	146.58	108.89
.5238	17.66	207.00	106.73	355.47	300.35	289.66	173.42	160.82	80.28	28.22
.6536	16.80	192.79	88.89	336.38	243.99	284.73	168.87	144.96	34.12	331.09
.7657	10.71	182.87	66.46	304.53	238.03	161.23	207.58	100.49	26.63	265.39
.8504	7.78	176.31	48.70	279.64	204.17	209.66	88.98	75.00	268.22	250.79
.9000	10.90	187.16	48.49	286.77	223.22	86.00	212.23	32.00	154.96	217.04

MEAN ANGLE = 18.00000 DEG FREQUENCY = 12.47115 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	5.9585	1.8959	.4850	.6320	.2641	.1170	.1034	.0977	.0439	.0508	.0252
.0615	2.4263	.9708	.2107	.3315	.1240	.0368	.0596	.0289	.0181	.0261	.0071
.1462	1.6072	.5990	.1416	.2160	.0305	.0479	.0220	.0252	.0193	.0339	.0174
.2583	1.2663	.4287	.1088	.1370	.0283	.0307	.0070	.0164	.0085	.0215	.0153
.3881	.9389	.3115	.0582	.0565	.0132	.0050	.0019	.0277	.0049	.0211	.0093
.5238	.7844	.2798	.0330	.0326	.0123	.0049	.0061	.0210	.0008	.0164	.0057
.6536	.7697	.2583	.0249	.0258	.0152	.0113	.0148	.0094	.0047	.0088	.0049
.7657	.5245	.2499	.0227	.0302	.0156	.0153	.0138	.0045	.0056	.0032	.0051
.8504	.4308	.2431	.0314	.0234	.0176	.0159	.0124	.0045	.0049	.0036	.0054
.9000	.3456	.2237	.0253	.0228	.0104	.0076	.0101	.0061	.0031	.0039	.0060

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	142.10	121.89	121.91	159.24	136.84	149.92	157.48	161.33	133.36	162.12
.0615	117.35	121.17	89.53	149.81	24.53	108.72	144.30	45.66	85.15	336.48
.1462	91.38	87.90	66.20	117.71	341.83	133.38	186.00	135.30	146.89	137.65
.2583	68.76	72.11	55.13	49.54	345.41	61.24	115.35	111.83	90.55	90.65
.3881	48.87	68.57	57.02	50.45	79.14	254.07	92.29	127.90	47.12	91.28
.5238	34.35	60.37	41.12	35.71	30.62	289.56	66.13	299.89	11.78	52.35
.6536	24.44	43.40	4.40	19.43	331.64	294.69	62.91	230.46	2.78	96.18
.7657	15.67	9.58	334.63	6.06	316.99	272.49	11.56	208.45	317.68	79.69
.8504	11.37	6.01	333.17	355.68	341.46	275.52	11.46	195.81	314.21	68.12
.9000	3.07	5.73	296.72	.26	343.68	244.10	27.34	139.22	316.12	39.05

TABLE II. - CONTINUED

MEAN ANGLE = 18.00000 DEG FREQUENCY = 30.95670 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	5.8786	1.8123	.6959	.4105	.2040	.0648	.0158	.0402	.0502	.0547	.0409
.0615	2.5000	1.3225	.3609	.3181	.1625	.0710	.0743	.0196	.0164	.0183	.0291
.1462	1.6074	.9127	.2055	.1813	.1034	.0315	.0463	.0397	.0278	.0251	.0342
.2583	1.2840	.7639	.1526	.1415	.0939	.0322	.0508	.0324	.0142	.0363	.0166
.3881	.9407	.6178	.0820	.0949	.0556	.0267	.0318	.0173	.0085	.0243	.0085
.5238	.7845	.5524	.0569	.0810	.0458	.0271	.0234	.0128	.0110	.0144	.0082
.6536	.7699	.4641	.0464	.0730	.0309	.0249	.0175	.0064	.0070	.0111	.0063
.7657	.5331	.3980	.0533	.0702	.0282	.0198	.0152	.0039	.0050	.0081	.0070
.8504	.4383	.3557	.0656	.0679	.0298	.0197	.0142	.0028	.0035	.0046	.0048
.9000	.3558	.3052	.0690	.0585	.0296	.0177	.0145	.0042	.0065	.0037	.0053

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	114.70	106.01	95.11	96.16	101.51	94.57	174.89	180.38	159.64	148.00
.0615	82.82	87.14	44.30	55.74	1.04	3.45	25.00	20.25	39.99	33.52
.1462	68.68	81.06	30.78	39.96	9.93	2.14	23.70	16.06	346.50	357.89
.2583	53.59	52.99	358.55	352.65	305.72	289.27	309.99	269.91	244.32	260.78
.3881	44.63	33.76	331.79	328.96	244.39	254.63	262.82	193.58	205.92	211.70
.5238	36.60	6.56	302.98	312.31	205.75	240.29	235.35	191.09	166.98	153.67
.6536	32.71	340.75	290.29	301.56	201.75	234.83	234.50	202.82	183.85	137.73
.7657	25.76	321.97	274.23	280.45	182.12	206.99	198.86	182.88	157.21	155.98
.8504	22.62	322.20	278.32	271.41	184.76	214.78	146.44	177.41	316.95	168.32
.9000	16.71	324.00	264.90	256.76	171.86	183.15	134.96	126.70	132.35	161.85

MEAN ANGLE = 18.00000 DEG FREQUENCY = 50.05642 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	5.7401	1.7636	.7754	.3335	.1187	.0318	.0679	.0909	.0760	.0520	.0320
.0615	2.2117	1.5549	.4068	.2683	.1259	.0546	.0573	.0412	.0403	.0439	.0304
.1462	1.9503	1.1685	.2497	.1662	.0956	.0284	.0446	.0487	.0206	.0375	.0220
.2583	.9494	1.0487	.2163	.1625	.1130	.0343	.0436	.0408	.0131	.0253	.0138
.3881	.9449	.8494	.1399	.1146	.0906	.0404	.0354	.0283	.0102	.0191	.0118
.5238	.8285	.7293	.1196	.0954	.0783	.0346	.0315	.0191	.0068	.0125	.0099
.6536	.7686	.6099	.1112	.0834	.0590	.0239	.0179	.0116	.0029	.0088	.0040
.7657	.6037	.5025	.1217	.0821	.0552	.0289	.0124	.0057	.0032	.0068	.0046
.8504	.5484	.4713	.1428	.0776	.0623	.0228	.0121	.0116	.0039	.0082	.0090
.9000	.4600	.3467	.1260	.0626	.0534	.0285	.0119	.0127	.0015	.0039	.0087

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	101.41	93.51	96.80	90.79	187.51	173.83	162.22	148.51	116.84	103.03
.0615	72.85	68.36	39.83	39.92	.47	31.68	48.11	19.93	14.11	4.56
.1462	59.98	58.18	9.88	358.49	354.21	340.62	339.82	319.20	297.87	306.48
.2583	49.45	27.70	328.31	303.43	254.22	240.50	260.50	189.37	195.21	230.43
.3881	42.20	1.49	290.70	265.02	189.11	164.81	206.84	103.54	127.46	162.94
.5238	36.78	335.54	263.43	243.89	167.45	135.88	167.92	71.37	71.63	132.05
.6536	32.01	311.72	239.47	223.43	130.40	95.42	180.61	55.13	60.58	121.00
.7657	27.63	297.52	229.03	198.84	111.64	53.36	125.53	42.44	48.74	19.45
.8504	23.07	296.70	232.23	188.09	119.72	48.84	138.29	140.44	69.02	51.84
.9000	21.27	292.45	224.18	177.35	95.51	22.40	25.90	90.36	265.12	16.95

TABLE II. - CONCLUDED

MEAN ANGLE = 18.00000 DEG FREQUENCY = 74.68113 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	5.7360	1.7177	.8411	.2871	.1805	.0246	.0496	.0932	.0953	.0724	.0579
.0615	2.3027	1.8146	.4197	.2392	.1207	.0933	.0684	.0547	.0492	.0376	.0348
.1462	2.0795	1.4786	.2620	.1660	.0857	.0525	.0475	.0324	.0240	.0329	.0216
.2583	1.0484	1.3302	.2473	.1766	.0906	.0481	.0350	.0204	.0115	.0256	.0153
.3881	1.0275	1.0864	.2046	.1604	.0767	.0339	.0334	.0180	.0106	.0152	.0104
.5238	.8922	.9104	.1797	.1453	.0701	.0225	.0312	.0126	.0021	.0160	.0079
.6536	.8189	.7512	.1736	.1327	.0633	.0183	.0190	.0138	.0041	.0131	.0069
.7657	.6494	.6018	.1896	.1295	.0711	.0453	.0233	.0137	.0065	.0178	.0094
.8504	.5742	.5561	.1899	.1259	.0718	.0324	.0264	.0088	.0051	.0133	.0095
.9000	.4821	.3258	.1644	.0971	.0681	.0609	.0283	.0070	.0077	.0270	.0089

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	80.91	70.06	72.79	53.10	33.39	138.99	101.94	45.84	6.92	312.80
.0615	53.61	33.37	7.06	355.09	310.58	307.78	288.86	274.41	254.78	232.74
.1462	42.67	5.47	311.49	289.42	231.39	244.65	234.17	191.81	183.07	159.35
.2583	33.79	328.55	260.81	231.95	175.41	156.46	161.58	125.30	95.95	80.92
.3881	27.47	292.74	211.50	161.84	103.00	58.32	66.60	344.97	353.78	326.54
.5238	23.55	272.06	186.74	119.70	56.45	349.45	23.81	145.43	300.62	259.56
.6536	20.50	257.84	169.18	96.56	12.51	306.93	358.11	63.69	262.25	276.92
.7657	13.99	244.94	156.03	75.70	345.49	271.98	348.37	200.29	219.79	236.33
.8504	11.11	244.01	149.11	60.33	335.55	268.73	262.10	85.06	193.64	187.63
.9000	11.82	240.82	140.94	50.05	323.54	233.42	316.46	182.22	185.60	143.06

MEAN ANGLE = 18.00000 DEG FREQUENCY = 98.63935 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	5.6026	1.6807	.9008	.3413	.1782	.0393	.1032	.0873	.0717	.0368	.0129
.0615	2.3585	2.0391	.4153	.2615	.1425	.0963	.0522	.0374	.0563	.0460	.0385
.1462	2.1695	1.7057	.2453	.1550	.0751	.0638	.0557	.0296	.0324	.0247	.0190
.2583	1.1122	1.5000	.2449	.1613	.0746	.0519	.0467	.0333	.0298	.0309	.0153
.3881	1.0868	1.2032	.2353	.1712	.0756	.0342	.0311	.0162	.0161	.0163	.0051
.5238	.9405	.9676	.2125	.1417	.0615	.0227	.0340	.0155	.0126	.0109	.0039
.6536	.8750	.7879	.2195	.1370	.0532	.0282	.0160	.0090	.0112	.0113	.0047
.7657	.6907	.5757	.2342	.1342	.0559	.0440	.0052	.0037	.0116	.0161	.0071
.8504	.5928	.5405	.2124	.1261	.0575	.0482	.0164	.0086	.0085	.0121	.0071
.9000	.4970	.1986	.1538	.0828	.0419	.0441	.0145	.0100	.0102	.0076	.0048

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	68.58	57.42	41.54	358.41	123.29	52.24	355.67	305.07	248.76	206.15
.0615	39.29	11.92	343.44	301.95	248.04	245.45	247.22	213.37	169.45	119.98
.1462	29.90	329.07	273.94	248.61	179.93	184.51	134.24	107.76	78.07	36.19
.2583	21.62	284.01	208.07	182.83	121.46	97.36	71.34	6.88	330.56	273.13
.3881	16.17	248.19	156.33	106.77	19.32	358.29	332.58	258.63	220.15	146.95
.5238	12.93	224.88	123.11	74.15	324.82	301.51	251.33	154.76	141.64	78.35
.6536	3.02	209.98	103.13	38.35	267.59	281.39	232.26	164.77	101.06	37.02
.7657	359.99	194.97	84.96	348.41	251.90	152.40	200.33	146.92	59.37	302.15
.8504	.60	190.78	72.92	326.74	236.96	192.46	29.67	99.42	51.55	291.37
.9000	358.92	194.14	74.56	315.63	245.33	122.65	163.15	14.87	42.83	287.74

TABLE III. - PRESSURE HARMONICS FOR FORWARD RAMP MOTION

MEAN ANGLE = 6.00000 DEG FREQUENCY = 7.46229 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.5253	2.7373	.6518	.0581	.0855	.0676	.0295	.0132	.0198	.0200	.0155
.0615	.9180	1.9529	.4480	.0588	.0408	.0361	.0198	.0077	.0133	.0151	.0123
.1462	1.2428	1.0468	.2446	.0231	.0239	.0242	.0118	.0048	.0125	.0070	.0051
.2583	.6835	.7073	.1614	.0201	.0207	.0156	.0070	.0014	.0012	.0051	.0055
.3881	.5042	.4910	.1129	.0122	.0122	.0123	.0060	.0014	.0063	.0037	.0032
.5238	.5604	.3608	.0783	.0134	.0085	.0074	.0047	.0023	.0050	.0035	.0010
.6536	.0915	.1456	.0343	.0049	.0045	.0057	.0033	.0009	.0041	.0006	.0019
.7657	-.1227	.2999	.0693	.0108	.0095	.0092	.0044	.0013	.0053	.0030	.0029
.8504	-.0972	.1398	.0313	.0088	.0054	.0042	.0018	.0022	.0096	.0043	.0044
.9000	.2750	.1058	.0273	.0011	.0041	.0038	.0007	.0006	.0040	.0005	.0008

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	351.15	333.27	274.05	159.13	140.06	126.74	88.09	2.62	290.31	269.49
.0615	349.10	348.96	354.31	143.06	145.59	137.79	101.18	348.91	275.27	278.22
.1462	350.93	348.21	355.82	161.23	149.47	152.69	102.90	4.30	295.17	276.95
.2583	352.22	341.69	321.63	174.29	165.10	142.44	185.06	350.14	298.07	279.54
.3881	353.11	347.63	332.13	178.86	163.55	155.16	116.45	.90	307.17	295.74
.5238	354.70	347.09	312.77	204.71	163.59	133.55	138.99	343.39	334.53	315.31
.6536	356.26	356.83	1.56	209.58	166.71	173.63	151.38	44.60	216.14	318.64
.7657	355.43	353.03	343.11	197.76	182.88	182.39	165.67	13.29	335.78	327.75
.8504	356.53	359.30	318.32	195.43	212.04	211.93	140.60	188.83	50.50	50.32
.9000	358.19	354.01	331.71	186.26	150.23	197.43	151.07	351.57	359.97	347.38

MEAN ANGLE = 6.00000 DEG FREQUENCY = 9.88648 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.5327	2.7239	.6562	.0596	.0977	.0643	.0311	.0125	.0064	.0230	.0178
.0615	.9080	1.9386	.4540	.0564	.0488	.0345	.0244	.0077	.0058	.0159	.0148
.1462	1.2429	1.0379	.2489	.0223	.0306	.0244	.0143	.0062	.0018	.0080	.0060
.2583	.6973	.6995	.1642	.0191	.0250	.0148	.0129	.0014	.0042	.0055	.0058
.3881	.5239	.4865	.1158	.0124	.0164	.0118	.0080	.0022	.0015	.0047	.0040
.5238	.6016	.3584	.0810	.0133	.0113	.0071	.0053	.0020	.0018	.0042	.0019
.6536	.0708	.1399	.0356	.0055	.0058	.0037	.0043	.0008	.0006	.0026	.0024
.7657	-.1788	.2962	.0718	.0102	.0126	.0094	.0061	.0017	.0017	.0035	.0028
.8504	-.1375	.1442	.0305	.0045	.0052	.0041	.0012	.0007	.0005	.0013	.0018
.9000	.3089	.1041	.0287	.0015	.0056	.0034	.0031	.0007	.0004	.0015	.0009

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	351.55	334.22	268.35	158.80	140.70	137.80	102.38	345.64	296.86	266.10
.0615	349.33	349.50	354.14	146.75	144.36	157.51	119.41	287.67	284.90	271.71
.1462	351.65	349.81	355.19	163.54	152.08	174.56	127.87	248.63	311.97	280.13
.2583	353.05	343.64	321.69	173.90	164.79	142.46	183.57	332.03	312.18	279.39
.3881	354.51	350.76	329.47	180.13	165.08	169.92	127.37	323.35	325.36	308.81
.5238	356.35	350.36	307.46	202.23	168.74	164.80	138.95	311.42	338.09	314.03
.6536	359.15	4.06	350.70	202.40	183.29	190.00	149.03	98.45	11.39	321.58
.7657	357.54	356.85	343.48	194.80	180.66	182.58	172.36	327.68	337.22	307.30
.8504	1.28	3.84	349.16	215.74	175.37	29.85	259.50	62.69	3.61	337.60
.9000	1.07	359.61	338.87	187.49	159.28	204.76	130.74	25.74	3.76	321.96

TABLE III. - CONTINUED

MEAN ANGLE = 6.00000 DEG   FREQUENCY = 14.18783 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.5306	2.6914	.6490	.0687	.0999	.0627	.0279	.0145	.0093	.0196	.0130
.0615	.8851	1.9161	.4478	.0484	.0528	.0344	.0205	.0090	.0080	.0151	.0117
.1462	1.2415	1.0248	.2423	.0178	.0320	.0226	.0120	.0059	.0032	.0078	.0042
.2583	.7079	.6902	.1580	.0192	.0265	.0143	.0077	.0018	.0043	.0049	.0042
.3881	.5474	.4801	.1128	.0116	.0182	.0115	.0050	.0018	.0020	.0042	.0037
.5238	.6501	.3552	.0793	.0136	.0140	.0075	.0038	.0024	.0020	.0050	.0021
.6536	.0487	.1396	.0350	.0049	.0073	.0034	.0018	.0022	.0002	.0020	.0018
.7657	-.2414	.2944	.0707	.0100	.0145	.0092	.0050	.0017	.0018	.0047	.0020
.8504	-.1835	.1477	.0368	.0038	.0089	.0046	.0030	.0006	.0009	.0017	.0025
.9000	.3465	.1027	.0268	.0018	.0054	.0028	.0016	.0010	.0009	.0018	.0009

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	349.66	329.96	253.59	150.64	131.34	117.71	82.71	303.28	268.01	253.75
.0615	347.40	345.28	342.16	137.97	138.07	135.82	98.00	264.85	256.75	256.29
.1462	350.28	346.65	336.79	161.37	142.77	146.73	119.44	264.40	283.76	277.66
.2583	351.95	341.02	303.48	168.66	162.61	147.11	169.13	324.86	308.02	278.87
.3881	354.29	349.65	308.70	175.94	162.00	154.81	135.51	318.39	308.56	308.30
.5238	356.78	350.47	291.63	196.04	168.09	147.45	143.53	303.72	325.62	339.04
.6536	.86	7.17	336.84	210.82	190.55	226.78	219.64	201.38	342.87	345.05
.7657	358.48	357.89	324.70	196.44	177.71	177.89	169.26	340.31	321.49	308.91
.8504	4.73	6.21	345.97	201.05	171.93	195.23	127.60	72.47	316.06	335.36
.9000	3.21	4.51	311.91	192.87	164.25	200.36	150.73	30.45	346.57	333.64

MEAN ANGLE = 6.00000 DEG   FREQUENCY = 19.87998 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.5520	2.7432	.6593	.0653	.1103	.0688	.0264	.0132	.0130	.0312	.0255
.0615	.8934	1.9575	.4569	.0542	.0571	.0378	.0193	.0094	.0039	.0223	.0247
.1462	1.2513	1.0491	.2479	.0263	.0343	.0240	.0107	.0044	.0023	.0132	.0093
.2583	.7208	.7094	.1622	.0183	.0293	.0155	.0047	.0024	.0058	.0075	.0074
.3881	.5634	.4934	.1165	.0134	.0208	.0124	.0052	.0021	.0017	.0069	.0074
.5238	.6839	.3661	.0834	.0141	.0174	.0090	.0036	.0030	.0015	.0083	.0067
.6536	.0370	.1476	.0395	.0070	.0066	.0043	.0045	.0032	.0015	.0048	.0064
.7657	-.2662	.3059	.0769	.0116	.0178	.0114	.0055	.0028	.0029	.0079	.0035
.8504	-.2236	.1437	.0375	.0077	.0101	.0057	.0026	.0011	.0015	.0035	.0033
.9000	.3711	.1101	.0300	.0046	.0067	.0035	.0035	.0012	.0013	.0040	.0032

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	348.33	325.21	248.01	144.98	121.91	101.99	69.91	325.28	275.59	252.67
.0615	346.21	340.95	342.99	135.04	130.94	126.25	94.72	229.92	280.75	269.07
.1462	349.89	343.90	352.83	159.68	140.96	147.38	114.27	309.02	302.60	296.94
.2583	351.97	339.09	284.17	167.88	161.68	161.70	153.18	331.15	300.96	269.58
.3881	355.30	349.42	322.64	178.09	165.82	162.97	120.98	14.17	336.34	325.83
.5238	358.25	351.76	294.83	194.13	173.72	148.14	132.39	347.15	341.18	341.77
.6536	4.87	11.88	.62	215.41	194.24	205.60	174.80	122.05	14.64	351.18
.7657	1.31	.69	335.93	193.47	179.69	180.10	183.85	349.16	358.43	22.86
.8504	8.79	12.43	232.10	202.87	182.63	181.54	175.47	8.03	13.10	9.05
.9000	7.37	8.26	350.85	196.28	187.90	233.40	154.80	29.07	10.89	7.23

TABLE III. - CONTINUED

MEAN ANGLE = 11.00000 DEG FREQUENCY = 7.56738 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8693	1.2407	1.2322	.6767	.1562	.1553	.2121	.1611	.0564	.0284	.0695
.0615	1.7545	1.0411	.7057	.3210	.0738	.0526	.0606	.0614	.0454	.0440	.0207
.1462	2.0554	.8640	.2670	.0486	.0161	.0400	.0312	.0134	.0031	.0162	.0168
.2583	1.0429	.6261	.2235	.0130	.0403	.0188	.0251	.0181	.0195	.0091	.0082
.3881	.7988	.3660	.1685	.0279	.0098	.0135	.0181	.0108	.0111	.0073	.0070
.5238	.6622	.3018	.1243	.0190	.0094	.0170	.0117	.0066	.0127	.0152	.0112
.6536	.3803	.1859	.0517	.0145	.0111	.0182	.0147	.0096	.0090	.0078	.0066
.7657	.3535	.3144	.0934	.0081	.0169	.0260	.0214	.0102	.0152	.0159	.0117
.8504	.1744	.2429	.0643	.0254	.0184	.0262	.0192	.0108	.0046	.0104	.0078
.9000	.3369	.1767	.0513	.0158	.0150	.0168	.0107	.0050	.0098	.0055	.0038

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	354.14	66.16	17.61	319.97	319.16	262.66	192.77	114.86	126.57	73.54
.0615	354.59	57.17	25.71	294.34	250.04	237.63	188.89	95.48	16.48	327.91
.1462	359.67	23.88	52.42	57.58	244.99	158.96	21.17	312.89	73.09	346.06
.2583	2.82	14.88	248.52	121.17	318.07	197.85	94.56	331.63	260.36	107.37
.3881	4.69	32.15	351.37	150.29	281.02	209.56	138.08	44.80	28.85	28.21
.5238	5.93	27.31	357.56	226.67	224.59	170.07	136.95	71.09	26.18	332.76
.6536	5.07	336.72	213.25	207.69	173.19	95.96	31.45	22.55	331.58	265.07
.7657	6.20	3.35	246.19	216.66	183.61	110.69	52.59	34.95	348.87	283.36
.8504	5.89	303.51	216.65	226.75	170.29	93.20	31.62	359.80	329.65	275.00
.9000	4.69	312.95	213.33	207.81	157.04	74.31	32.24	15.30	302.58	209.04

MEAN ANGLE = 11.00000 DEG FREQUENCY = 9.98814 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8884	1.2319	1.2462	.6393	.1473	.1867	.2326	.1536	.0432	.0582	.0899
.0615	1.7651	1.0557	.7237	.2981	.0724	.0719	.0801	.0612	.0266	.0236	.0249
.1462	2.0825	.8936	.2720	.0431	.0160	.0617	.0409	.0136	.0078	.0215	.0186
.2583	1.0590	.6478	.2340	.0341	.0319	.0153	.0222	.0124	.0061	.0077	.0140
.3881	.8188	.3815	.1801	.0355	.0151	.0150	.0177	.0109	.0079	.0133	.0170
.5238	.6930	.3161	.1339	.0222	.0160	.0215	.0152	.0090	.0080	.0109	.0105
.6536	.3729	.1894	.0524	.0222	.0133	.0173	.0127	.0100	.0096	.0095	.0104
.7657	.3689	.3226	.0998	.0251	.0200	.0228	.0164	.0126	.0131	.0134	.0126
.8504	.1551	.2395	.0678	.0285	.0163	.0239	.0150	.0112	.0117	.0120	.0127
.9000	.3534	.1778	.0490	.0217	.0097	.0110	.0086	.0033	.0049	.0052	.0054

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	355.93	63.04	13.16	326.35	312.15	252.85	185.63	146.06	136.70	65.25
.0615	356.50	52.87	17.20	289.39	251.30	223.42	168.95	91.77	23.20	20.33
.1462	.82	20.25	32.92	333.69	228.08	149.76	33.78	194.27	58.85	336.09
.2583	4.53	11.82	264.75	139.87	253.81	205.35	84.00	338.27	50.09	2.36
.3881	7.85	27.44	315.63	182.60	250.21	199.34	133.18	74.00	49.88	1.01
.5238	9.26	21.57	310.00	213.53	209.05	141.58	69.93	31.24	7.28	317.61
.6536	7.58	333.71	211.05	182.38	164.12	77.69	30.44	2.31	320.47	249.50
.7657	8.59	358.56	240.08	193.25	175.91	103.10	36.44	3.47	328.34	265.71
.8504	6.22	306.73	196.52	203.18	153.08	91.57	41.71	6.40	314.05	253.50
.9000	5.56	303.72	197.18	175.96	152.34	50.65	17.55	10.11	323.46	246.68

TABLE III. - CONTINUED

MEAN ANGLE = 11.00000 DEG FREQUENCY = 14.19522 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8843	1.2270	1.2334	.6178	.1738	.1845	.2134	.1401	.0570	.0624	.0727
.0615	1.7651	1.0785	.7323	.2882	.0961	.0832	.0662	.0532	.0357	.0424	.0270
.1462	2.0670	.8744	.3247	.0417	.0233	.0607	.0417	.0145	.0065	.0228	.0175
.2583	1.0536	.6396	.2625	.0410	.0260	.0238	.0310	.0214	.0148	.0058	.0084
.3881	.8229	.3851	.1954	.0339	.0165	.0199	.0176	.0095	.0076	.0107	.0091
.5238	.7030	.3188	.1412	.0198	.0208	.0263	.0129	.0050	.0047	.0104	.0066
.6536	.3632	.1832	.0434	.0188	.0099	.0101	.0120	.0091	.0062	.0065	.0030
.7657	.3718	.3165	.0965	.0155	.0171	.0192	.0139	.0097	.0063	.0097	.0057
.8504	.1392	.2408	.0517	.0302	.0104	.0133	.0147	.0106	.0073	.0052	.0021
.9000	.3660	.1720	.0390	.0176	.0068	.0056	.0073	.0061	.0072	.0035	.0014

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	358.66	59.23	13.14	326.39	302.71	246.51	186.73	150.64	108.30	47.25
.0615	359.32	46.22	12.35	277.20	226.78	205.80	169.33	102.30	22.22	340.93
.1462	4.15	16.80	347.09	249.81	213.37	147.36	58.78	88.39	31.81	328.32
.2583	7.58	9.16	264.55	160.93	220.50	151.20	50.90	325.70	357.56	319.27
.3881	12.77	22.69	303.48	203.19	226.55	168.25	80.79	28.55	18.85	312.50
.5238	13.62	20.41	316.02	234.69	192.84	108.74	4.13	43.37	7.44	285.94
.6536	9.59	353.79	179.67	171.85	114.76	346.83	238.23	107.34	36.34	305.20
.7657	11.63	1.96	215.61	201.87	147.65	28.82	270.52	113.40	35.16	311.32
.8504	7.25	297.16	171.27	155.32	108.52	345.20	245.09	115.36	56.72	12.89
.9000	6.15	297.79	170.48	178.27	105.19	305.09	169.59	56.18	359.75	332.95

MEAN ANGLE = 11.00000 DEG FREQUENCY = 19.73581 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.8916	1.2758	1.2096	.5943	.1884	.1935	.2004	.1196	.0479	.0620	.0778
.0615	1.7664	1.1286	.7459	.2736	.1050	.0935	.0843	.0570	.0293	.0308	.0245
.1462	2.0636	.8900	.3529	.0638	.0527	.0686	.0390	.0128	.0137	.0253	.0180
.2583	1.0628	.6688	.2728	.0566	.0410	.0285	.0199	.0102	.0054	.0136	.0142
.3881	.8446	.4171	.1991	.0364	.0277	.0239	.0147	.0084	.0047	.0107	.0057
.5238	.7243	.3468	.1476	.0191	.0221	.0186	.0065	.0041	.0041	.0104	.0037
.6536	.3481	.1737	.0396	.0155	.0053	.0016	.0040	.0006	.0021	.0022	.0042
.7657	.3741	.3237	.1042	.0211	.0151	.0067	.0031	.0013	.0032	.0046	.0024
.8504	.1100	.2111	.0326	.0214	.0055	.0031	.0047	.0013	.0030	.0038	.0031
.9000	.3654	.1572	.0273	.0089	.0072	.0022	.0035	.0025	.0033	.0009	.0034

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	358.53	45.25	356.69	301.28	265.76	204.99	140.90	105.21	51.58	352.83
.0615	359.03	30.36	350.69	247.34	199.69	162.46	105.52	22.82	323.48	331.30
.1462	3.26	5.14	320.46	221.57	177.06	116.84	56.84	44.94	351.79	318.93
.2583	6.51	356.48	253.66	171.46	154.35	94.24	353.91	301.40	352.40	295.61
.3881	12.73	8.61	282.94	199.30	177.72	110.15	11.08	328.38	354.58	283.51
.5238	13.90	4.97	266.98	195.99	169.95	91.06	331.73	8.87	341.51	232.85
.6536	12.41	341.69	156.61	155.87	151.17	290.71	180.09	342.99	33.69	76.05
.7657	13.72	353.89	197.32	167.25	139.52	318.93	234.47	355.29	359.42	114.01
.8504	8.32	319.23	166.47	185.84	126.08	279.31	241.75	59.05	56.85	36.57
.9000	8.77	309.15	155.05	191.38	119.40	249.26	70.35	340.31	351.83	108.08

TABLE III. - CONTINUED

MEAN ANGLE = 14.00000 DEG FREQUENCY = 7.55295 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.0103	.1171	1.3789	.4147	.4723	.0709	.2155	.1402	.0816	.1086	.0141
.0615	2.0417	.2574	.8114	.1581	.1826	.0472	.0509	.0800	.0316	.0278	.0228
.1462	2.2028	.5485	.3653	.0930	.0087	.0149	.0244	.0084	.0324	.0165	.0030
.2583	1.2531	.5057	.2176	.0565	.0352	.0314	.0116	.0164	.0132	.0069	.0066
.3881	.9032	.3017	.1499	.0387	.0113	.0131	.0229	.0178	.0090	.0128	.0090
.5238	.7298	.2683	.1204	.0257	.0162	.0070	.0190	.0216	.0115	.0095	.0081
.6536	.5861	.1981	.0514	.0245	.0362	.0216	.0144	.0104	.0069	.0101	.0073
.7657	.4601	.3105	.1017	.0281	.0408	.0251	.0176	.0182	.0191	.0195	.0129
.8504	.3912	.2575	.0605	.0375	.0481	.0274	.0219	.0180	.0187	.0114	.0113
.9000	.3550	.2042	.0441	.0301	.0343	.0172	.0130	.0099	.0105	.0088	.0060

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	121.96	63.77	96.44	55.00	24.09	25.39	302.84	329.07	274.88	249.42
.0615	19.77	54.51	83.34	60.93	298.22	32.16	295.03	237.86	289.86	156.07
.1462	3.78	45.33	24.71	231.73	264.65	211.76	337.54	235.65	83.92	323.10
.2583	5.58	29.49	38.84	271.51	177.23	276.68	184.24	331.97	135.67	57.20
.3881	9.23	32.70	76.66	329.60	140.73	323.44	225.42	291.33	200.03	96.30
.5238	11.13	25.86	45.86	283.47	196.20	287.81	216.72	174.66	121.61	74.64
.6536	6.93	347.97	326.41	248.26	202.24	190.75	168.57	139.24	79.61	40.58
.7657	10.00	7.81	352.51	261.22	214.37	223.97	200.22	173.88	99.70	53.11
.8504	6.14	340.04	331.89	254.69	214.01	191.64	173.40	116.44	71.19	57.97
.9000	4.23	332.20	320.93	247.85	205.74	183.58	154.64	109.54	42.36	13.92

MEAN ANGLE = 14.00000 DEG FREQUENCY = 9.95688 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.9896	.1711	1.3561	.4772	.4323	.0950	.1881	.0924	.1096	.0878	.0332
.0615	2.0332	.2881	.8320	.2161	.1437	.0648	.0374	.0518	.0298	.0247	.0127
.1462	2.1972	.5596	.3676	.1587	.0446	.0215	.0557	.0125	.0296	.0197	.0093
.2583	1.2619	.5404	.1922	.0994	.0699	.0426	.0272	.0224	.0042	.0107	.0076
.3881	.9041	.3225	.1533	.0490	.0300	.0219	.0110	.0135	.0044	.0042	.0009
.5238	.7323	.2805	.1331	.0249	.0233	.0179	.0132	.0074	.0095	.0107	.0027
.6536	.5645	.1810	.0532	.0224	.0278	.0147	.0175	.0096	.0101	.0100	.0049
.7657	.4489	.2991	.1118	.0361	.0446	.0288	.0269	.0159	.0177	.0198	.0077
.8504	.3573	.2309	.0538	.0366	.0341	.0205	.0190	.0130	.0161	.0122	.0061
.9000	.3457	.1839	.0400	.0257	.0206	.0154	.0142	.0087	.0080	.0031	.0045

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	98.74	65.16	89.53	49.34	27.34	4.11	295.97	324.26	255.70	297.73
.0615	23.55	58.72	62.69	49.05	310.69	307.92	277.93	262.49	242.27	147.90
.1462	3.62	55.32	24.09	256.55	299.19	228.78	86.12	245.70	92.08	293.95
.2583	7.11	34.86	44.73	284.72	195.02	227.32	174.86	100.93	93.37	5.05
.3881	15.08	32.33	64.32	304.38	197.22	298.07	229.84	190.94	114.29	95.73
.5238	18.16	25.43	24.20	271.51	224.99	228.69	209.17	177.57	87.61	25.44
.6536	11.92	4.56	314.51	235.92	231.38	200.43	151.63	119.30	57.83	11.77
.7657	15.11	17.15	339.34	253.45	221.88	197.10	161.34	126.98	60.37	3.89
.8504	6.19	354.31	317.16	241.86	228.05	186.59	170.22	120.55	65.86	36.35
.9000	7.12	347.95	303.80	236.88	240.19	195.04	155.60	91.29	49.10	65.36

TABLE III. - CONCLUDED

MEAN ANGLE = 14.00000 DEG   FREQUENCY = 14.19293 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.9629	.2527	1.3119	.5313	.3871	.1193	.1951	.1021	.1133	.0736	.0334
.0615	2.0164	.3611	.8403	.2593	.1010	.0375	.0536	.0573	.0378	.0177	.0057
.1462	2.1791	.5666	.3955	.1889	.0817	.0126	.0450	.0114	.0222	.0095	.0025
.2583	1.2520	.5537	.2296	.1032	.0852	.0463	.0237	.0182	.0168	.0213	.0105
.3881	.9065	.3505	.1750	.0419	.0357	.0191	.0157	.0123	.0040	.0091	.0073
.5238	.7339	.2987	.1474	.0289	.0335	.0112	.0186	.0128	.0086	.0138	.0083
.6536	.5524	.1730	.0494	.0259	.0344	.0066	.0120	.0064	.0083	.0092	.0052
.7657	.4414	.2965	.1152	.0399	.0525	.0202	.0220	.0152	.0122	.0159	.0104
.8504	.3366	.2078	.0437	.0383	.0350	.0041	.0117	.0074	.0074	.0110	.0063
.9000	.3507	.1735	.0382	.0312	.0269	.0059	.0069	.0042	.0075	.0068	.0031

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	91.26	64.46	83.12	44.54	35.28	357.29	302.81	303.85	249.03	262.88
.0615	35.53	54.77	49.18	22.83	305.36	314.71	267.30	247.52	220.84	140.34
.1462	11.55	49.77	16.96	260.07	248.84	244.93	208.25	229.04	99.80	217.56
.2583	13.65	27.80	26.16	272.99	200.65	219.44	180.25	162.39	81.80	37.80
.3881	23.41	24.32	45.19	281.42	205.68	256.36	190.94	186.29	116.78	84.88
.5238	25.15	21.65	357.18	244.19	206.15	230.69	160.32	121.18	66.08	11.53
.6536	15.45	11.41	315.64	217.61	198.36	187.89	128.99	113.43	42.29	340.94
.7657	20.29	18.34	330.89	232.81	195.48	186.44	119.19	86.69	40.91	354.42
.8504	7.18	23.64	317.75	213.35	206.81	194.14	133.95	98.69	43.88	313.97
.9000	9.52	358.64	298.80	210.87	215.12	179.79	168.75	96.49	28.62	316.76

MEAN ANGLE = 14.00000 DEG   FREQUENCY = 19.75340 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.9006	.4155	1.2944	.5687	.4139	.1423	.2001	.1093	.1197	.0676	.0310
.0615	1.9660	.5040	.8745	.2474	.1408	.0785	.0552	.0583	.0387	.0118	.0158
.1462	2.1569	.6051	.4435	.1642	.0676	.0631	.0557	.0147	.0200	.0196	.0034
.2583	1.2696	.5972	.2616	.1211	.0937	.0562	.0447	.0334	.0223	.0209	.0146
.3881	.9371	.3974	.1823	.0562	.0533	.0318	.0124	.0092	.0057	.0113	.0088
.5238	.7546	.3411	.1546	.0356	.0476	.0299	.0101	.0040	.0055	.0075	.0090
.6536	.5398	.1826	.0593	.0210	.0299	.0152	.0075	.0020	.0021	.0047	.0066
.7657	.4452	.3257	.1263	.0334	.0521	.0290	.0123	.0052	.0060	.0050	.0089
.8504	.3189	.2144	.0563	.0307	.0341	.0165	.0078	.0020	.0025	.0054	.0051
.9000	.3543	.1763	.0428	.0250	.0259	.0096	.0047	.0038	.0017	.0065	.0026

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	83.89	49.90	66.04	17.10	353.62	311.83	258.61	247.48	193.61	173.76
.0615	44.44	34.89	32.56	345.04	253.52	254.71	214.02	189.72	140.64	70.16
.1462	15.04	29.37	351.39	257.12	236.56	179.36	163.75	138.41	18.73	353.65
.2583	10.37	16.61	343.61	239.22	190.02	162.07	106.89	47.93	.64	342.42
.3881	19.03	14.62	359.53	244.88	181.72	167.67	136.39	79.01	41.26	25.99
.5238	22.72	7.55	329.65	227.51	169.31	120.62	95.87	28.29	32.27	30.47
.6536	18.21	355.49	281.06	204.95	160.41	82.91	40.03	354.21	89.45	27.14
.7657	21.26	1.50	300.11	213.66	161.18	104.74	47.20	342.59	65.34	29.92
.8504	14.59	357.68	276.10	202.67	163.55	96.68	52.53	14.87	68.80	26.01
.9000	9.83	345.07	277.46	199.61	163.23	117.90	66.83	307.14	63.09	6.06

TABLE IV. - PRESSURE HARMONICS FOR BACKWARD RAMP MOTION

MEAN ANGLE = 6.00000 DEG FREQUENCY = 7.55851 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.5532	2.7082	.6122	.0250	.0793	.0507	.0192	.0095	.0059	.0185	.0132
.0615	.8709	1.9330	.4039	.0526	.0479	.0232	.0127	.0059	.0071	.0135	.0101
.1462	1.2446	1.0367	.2171	.0214	.0262	.0165	.0063	.0041	.0016	.0067	.0037
.2583	.7360	.6985	.1440	.0123	.0180	.0085	.0026	.0003	.0120	.0046	.0046
.3881	.5890	.4850	.0997	.0078	.0123	.0056	.0021	.0014	.0004	.0045	.0018
.5238	.7289	.3560	.0721	.0079	.0075	.0032	.0026	.0020	.0011	.0018	.0029
.6536	.0111	.1433	.0265	.0042	.0046	.0016	.0006	.0013	.0021	.0022	.0010
.7657	-.2241	.2964	.0598	.0073	.0067	.0034	.0016	.0010	.0019	.0032	.0016
.8504	-.2816	.1402	.0338	.0028	.0026	.0043	.0006	.0011	.0031	.0010	.0016
.9000	.4076	.1043	.0218	.0008	.0039	.0025	.0007	.0005	.0010	.0016	.0007

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	342.28	155.23	29.21	294.38	85.72	251.48	65.82	335.87	204.72	13.99
.0615	343.70	137.40	248.60	312.71	83.30	232.06	48.41	22.44	208.32	356.08
.1462	345.01	144.51	239.35	312.88	83.17	232.26	57.19	218.29	229.62	27.24
.2583	344.73	154.96	281.81	312.34	58.49	214.18	25.82	22.82	228.06	30.47
.3881	346.32	153.93	261.29	325.15	81.13	234.30	79.79	20.79	233.85	38.60
.5238	347.06	161.28	307.64	348.11	131.76	292.53	55.59	51.39	247.51	86.12
.6536	351.19	162.38	251.91	356.45	91.10	77.74	118.11	356.92	277.12	53.33
.7657	349.25	160.87	248.81	334.79	75.09	147.20	99.05	305.36	272.19	58.84
.8504	350.16	158.69	265.13	314.54	150.54	274.94	42.89	95.60	283.14	70.39
.9000	351.71	167.94	159.18	330.05	89.90	4.67	62.13	167.28	290.19	120.35

MEAN ANGLE = 6.00000 DEG FREQUENCY = 10.02204 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.5781	2.7177	.6263	.0346	.0923	.0542	.0169	.0093	.0053	.0168	.0142
.0615	.8913	1.9388	.4127	.0471	.0546	.0267	.0173	.0075	.0058	.0129	.0109
.1462	1.2594	1.0375	.2252	.0191	.0301	.0182	.0138	.0045	.0024	.0068	.0043
.2583	.7502	.6989	.1503	.0101	.0206	.0086	.0036	.0009	.0030	.0056	.0050
.3881	.6023	.4856	.1036	.0063	.0144	.0062	.0048	.0022	.0009	.0044	.0028
.5238	.7571	.3579	.0750	.0071	.0092	.0050	.0010	.0023	.0014	.0021	.0035
.6536	.0019	.1419	.0284	.0049	.0050	.0015	.0034	.0010	.0015	.0027	.0020
.7657	-.1324	.2968	.0618	.0070	.0085	.0024	.0050	.0012	.0008	.0038	.0026
.8504	-.3206	.1458	.0322	.0024	.0056	.0031	.0095	.0011	.0015	.0017	.0011
.9000	.4234	.1037	.0238	.0009	.0041	.0027	.0042	.0007	.0006	.0011	.0010

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	342.86	157.08	41.45	295.17	93.78	236.63	76.72	29.16	215.40	30.22
.0615	344.16	139.12	251.85	311.99	90.51	187.70	50.16	52.85	221.49	7.07
.1462	345.90	146.31	240.84	314.30	99.76	170.90	61.79	125.28	243.98	60.35
.2583	345.81	156.18	288.21	308.93	89.41	280.69	41.18	37.22	247.34	49.98
.3881	347.82	156.67	263.70	326.18	111.56	156.94	92.23	103.69	253.71	65.41
.5238	348.84	164.91	311.62	349.21	154.56	180.28	58.26	41.34	274.92	87.22
.6536	353.71	165.20	249.48	356.50	165.20	163.73	338.68	159.85	260.78	86.47
.7657	351.45	162.91	250.61	339.15	134.09	155.17	72.34	82.34	273.65	84.03
.8504	353.82	180.31	239.53	.61	149.63	324.49	36.32	180.29	309.34	125.01
.9000	354.59	167.28	146.01	333.19	137.60	119.86	37.01	160.82	283.40	103.77

TABLE IV. - CONTINUED

MEAN ANGLE = 6.00000 DEG FREQUENCY = 14.08996 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.5868	2.7219	.6226	.0366	.0935	.0551	.0226	.0089	.0043	.0210	.0171
.0615	.8909	1.9425	.4041	.0428	.0565	.0279	.0136	.0077	.0050	.0164	.0137
.1462	1.2656	1.0432	.2198	.0159	.0319	.0182	.0077	.0049	.0036	.0076	.0052
.2583	.7566	.7039	.1480	.0081	.0212	.0082	.0030	.0010	.0023	.0059	.0063
.3881	.6140	.4891	.1024	.0046	.0165	.0074	.0025	.0020	.0015	.0049	.0032
.5238	.7748	.3605	.0762	.0063	.0125	.0074	.0040	.0017	.0006	.0029	.0048
.6536	-.0056	.1453	.0288	.0021	.0069	.0043	.0012	.0017	.0016	.0028	.0026
.7657	-.1145	.3017	.0627	.0048	.0120	.0049	.0016	.0007	.0006	.0043	.0034
.8504	-.3599	.1428	.0342	.0021	.0058	.0052	.0029	.0008	.0008	.0027	.0025
.9000	.4386	.1066	.0245	.0014	.0051	.0037	.0018	.0005	.0010	.0023	.0015

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	341.26	154.75	45.50	291.08	91.22	258.75	64.54	36.02	199.92	10.32
.0615	342.65	137.19	244.15	309.60	88.54	236.35	41.74	59.38	206.04	348.06
.1462	344.78	145.72	235.62	311.94	100.07	243.54	52.27	130.34	231.04	35.84
.2583	345.03	156.62	296.24	314.26	98.69	275.04	7.57	47.42	239.76	45.52
.3881	347.72	158.86	261.58	328.58	127.23	293.34	80.97	138.32	254.70	54.09
.5238	349.32	168.56	317.95	350.02	156.01	304.15	44.03	57.45	281.07	75.89
.6536	355.77	175.14	228.23	357.68	165.24	345.28	164.82	122.87	292.45	81.06
.7657	352.42	168.63	243.19	343.27	151.26	309.11	99.54	170.88	274.61	88.75
.8504	357.21	180.71	212.00	347.60	144.22	349.56	205.65	151.35	285.53	100.63
.9000	356.35	175.48	74.40	338.44	141.64	342.08	139.39	118.03	288.59	106.53

MEAN ANGLE = 6.00000 DEG FREQUENCY = 19.92027 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	2.5995	2.7053	.6201	.0457	.1033	.0586	.0291	.0116	.0132	.0244	.0271
.0615	.8851	1.9306	.4001	.0414	.0650	.0293	.0173	.0090	.0120	.0239	.0216
.1462	1.2754	1.0307	.2179	.0192	.0363	.0192	.0102	.0055	.0055	.0095	.0097
.2583	.7646	.6937	.1498	.0119	.0253	.0102	.0034	.0018	.0057	.0042	.0078
.3881	.6278	.4824	.1048	.0041	.0198	.0096	.0047	.0028	.0035	.0060	.0076
.5238	.7941	.3587	.0808	.0030	.0159	.0100	.0070	.0031	.0025	.0075	.0081
.6536	-.0114	.1446	.0326	.0064	.0090	.0055	.0009	.0008	.0030	.0057	.0048
.7657	-.0873	.2987	.0679	.0071	.0139	.0077	.0039	.0019	.0025	.0053	.0068
.8504	-.3578	.1525	.0347	.0043	.0079	.0062	.0047	.0014	.0030	.0032	.0052
.9000	.4577	.1053	.0272	.0038	.0058	.0037	.0027	.0009	.0017	.0042	.0038

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	342.24	158.31	71.09	293.51	100.81	273.24	64.16	44.96	217.94	29.07
.0615	343.52	140.58	221.25	308.03	96.83	252.21	25.80	65.50	238.07	26.42
.1462	346.63	151.83	190.27	315.43	113.43	260.57	40.75	97.07	254.29	65.25
.2583	347.46	164.50	267.45	317.11	118.04	297.01	62.20	77.14	264.71	69.22
.3881	351.28	168.69	177.86	335.11	146.65	305.48	80.57	129.89	295.01	99.22
.5238	353.54	179.41	.01	351.01	167.18	317.90	62.49	118.71	309.49	103.03
.6536	2.69	189.82	199.16	359.56	185.19	306.70	246.36	134.06	314.53	139.08
.7657	358.08	181.77	205.83	348.38	158.75	322.47	114.98	133.69	300.38	110.16
.8504	3.38	194.25	329.01	5.72	184.64	27.43	120.03	151.64	316.14	141.97
.9000	3.90	189.76	114.99	357.37	153.87	25.52	128.87	153.05	322.92	133.82

TABLE IV. - CONTINUED

MEAN ANGLE = 11.00000 DEG   FREQUENCY = 7.54488 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.2919	2.1629	.3841	.3748	.0691	.0655	.0505	.0353	.0150	.0147	.0332
.0615	1.9243	1.3490	.3098	.2370	.0413	.0406	.0327	.0242	.0135	.0090	.0170
.1462	2.0067	.7906	.1242	.1102	.0315	.0212	.0263	.0189	.0126	.0047	.0091
.2583	.9993	.5817	.0725	.0657	.0242	.0158	.0216	.0148	.0110	.0060	.0045
.3881	.7770	.4100	.0448	.0372	.0232	.0076	.0189	.0170	.0132	.0077	.0028
.5238	.5970	.3392	.0495	.0243	.0243	.0038	.0179	.0170	.0117	.0093	.0081
.6536	.4186	.1970	.0833	.0390	.0265	.0067	.0091	.0111	.0103	.0070	.0085
.7657	.3180	.3374	.0969	.0379	.0340	.0082	.0194	.0213	.0156	.0099	.0100
.8504	.2688	.2457	.1130	.0580	.0299	.0081	.0122	.0156	.0042	.0115	.0111
.9000	.2821	.1942	.0984	.0480	.0248	.0089	.0068	.0082	.0089	.0027	.0061

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	7.32	101.34	285.90	159.26	148.97	55.34	347.45	267.88	264.03	139.25
.0615	9.14	102.24	268.15	81.46	165.54	32.82	316.76	187.74	357.42	137.67
.1462	8.82	115.18	265.52	88.35	148.67	9.61	267.98	115.15	86.41	82.97
.2583	9.22	130.05	258.63	66.42	167.26	2.90	240.40	162.32	35.21	80.05
.3881	9.45	153.50	242.78	55.78	167.24	345.53	223.43	102.73	31.77	359.94
.5238	8.10	185.51	209.58	52.74	40.62	312.22	199.14	94.69	41.40	327.87
.6536	355.15	208.05	108.10	11.86	272.42	266.35	168.95	73.46	12.27	272.82
.7657	1.86	204.83	130.79	31.28	310.04	288.21	176.45	78.05	31.37	309.69
.8504	351.12	207.38	105.95	6.05	318.65	265.84	165.96	121.07	356.96	279.86
.9000	349.02	210.81	94.79	351.34	241.76	225.08	126.63	25.54	348.24	262.68

MEAN ANGLE = 11.00000 DEG   FREQUENCY = 9.91005 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.0600	1.9332	.4881	.5827	.2424	.0844	.0818	.0507	.0225	.0534	.0588
.0615	1.8808	1.3143	.2537	.2832	.1156	.0455	.0416	.0362	.0288	.0137	.0253
.1462	2.0669	.8663	.1535	.0509	.0152	.0493	.0470	.0190	.0120	.0163	.0193
.2583	1.0465	.6351	.1062	.0150	.0293	.0419	.0456	.0284	.0123	.0030	.0084
.3881	.7873	.4171	.0344	.0435	.0344	.0101	.0204	.0190	.0135	.0104	.0037
.5238	.6118	.3428	.0485	.0348	.0343	.0066	.0103	.0130	.0082	.0087	.0058
.6536	.4102	.1887	.0811	.0443	.0303	.0115	.0021	.0069	.0064	.0067	.0078
.7657	.3246	.3272	.0955	.0475	.0420	.0139	.0056	.0122	.0085	.0114	.0104
.8504	.2412	.2434	.1121	.0545	.0273	.0084	.0152	.0118	.0113	.0079	.0076
.9000	.2873	.1778	.0891	.0425	.0211	.0067	.0006	.0080	.0084	.0079	.0080

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	19.88	40.86	249.08	89.80	276.04	108.12	338.41	153.00	307.35	160.62
.0615	14.15	79.92	242.00	59.92	238.49	88.64	345.12	212.92	327.40	152.66
.1462	4.77	146.35	274.10	309.22	125.48	358.26	231.22	207.46	122.26	35.21
.2583	5.60	164.00	234.96	328.48	141.82	346.97	213.22	107.82	23.93	45.60
.3881	11.91	181.82	206.57	35.73	189.46	353.41	212.77	113.89	10.06	273.11
.5238	11.29	202.42	180.27	30.35	236.03	331.31	187.78	96.80	9.34	259.24
.6536	357.42	206.40	106.19	358.45	243.07	188.24	143.64	46.92	316.39	215.95
.7657	4.46	206.01	125.84	12.00	235.26	332.18	172.21	83.02	355.21	230.55
.8504	352.59	206.00	90.54	347.30	251.42	227.75	123.69	9.38	290.42	186.29
.9000	350.64	207.23	90.99	340.71	215.75	119.87	119.26	356.74	254.66	148.14

TABLE IV. - CONTINUED

MEAN ANGLE = 11.00000 DEG FREQUENCY = 14.13454 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	3.9646	1.8890	.5663	.6313	.2309	.0280	.0531	.0532	.0568	.0620	.0430
.0615	1.8356	1.3409	.1986	.3040	.1310	.0286	.0100	.0134	.0111	.0335	.0437
.1462	2.0751	.9159	.1388	.0347	.0313	.0182	.0191	.0018	.0220	.0291	.0259
.2583	1.0606	.6849	.1258	.0263	.0450	.0300	.0225	.0138	.0073	.0115	.0070
.3881	.7930	.4393	.0489	.0406	.0353	.0081	.0154	.0191	.0141	.0139	.0100
.5238	.6206	.3595	.0616	.0365	.0379	.0112	.0094	.0152	.0114	.0107	.0108
.6536	.3931	.1754	.0719	.0368	.0269	.0138	.0037	.0050	.0072	.0053	.0043
.7657	.3189	.3273	.0984	.0484	.0438	.0222	.0035	.0123	.0113	.0068	.0078
.8504	.2070	.2150	.0985	.0466	.0273	.0154	.0077	.0052	.0084	.0054	.0044
.9000	.2818	.1579	.0732	.0319	.0163	.0098	.0059	.0038	.0042	.0031	.0002

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	23.04	32.16	249.31	106.67	42.42	2.91	235.22	97.35	304.03	151.48
.0615	15.93	62.12	232.18	62.85	271.50	223.87	81.43	334.01	260.03	120.45
.1462	4.94	168.55	220.32	9.97	128.20	312.07	82.76	225.48	104.07	357.08
.2583	4.81	185.14	129.72	340.10	162.18	343.22	196.16	143.14	44.57	317.13
.3881	12.98	210.97	186.44	26.97	204.94	316.24	186.24	82.07	343.47	218.35
.5238	12.69	215.15	162.14	20.90	249.92	257.47	146.90	38.23	309.39	193.15
.6536	2.93	204.89	89.49	337.48	204.50	111.58	86.02	315.72	174.01	82.82
.7657	7.26	208.59	110.47	354.93	224.57	171.59	115.09	347.23	241.99	136.19
.8504	356.94	202.94	81.76	336.81	210.89	117.02	40.34	295.64	184.57	95.31
.9000	355.50	205.03	76.37	323.55	198.33	93.89	2.12	249.65	109.98	285.80

MEAN ANGLE = 11.00000 DEG FREQUENCY = 19.90382 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.0042	1.9815	.5084	.5893	.2116	.0384	.0471	.0452	.0493	.0516	.0359
.0615	1.8641	1.4471	.1222	.2750	.1253	.0280	.0040	.0102	.0132	.0154	.0347
.1462	2.0812	.9666	.1473	.0554	.0501	.0192	.0222	.0134	.0196	.0273	.0195
.2583	1.0627	.7149	.1358	.0505	.0534	.0190	.0139	.0176	.0042	.0086	.0053
.3881	.8106	.4711	.0768	.0497	.0425	.0127	.0092	.0162	.0102	.0084	.0095
.5238	.6433	.3873	.0880	.0451	.0423	.0187	.0054	.0072	.0047	.0046	.0096
.6536	.3962	.1866	.0854	.0433	.0270	.0170	.0101	.0071	.0043	.0076	.0051
.7657	.3384	.3498	.1226	.0623	.0466	.0293	.0139	.0056	.0040	.0052	.0042
.8504	.2040	.2181	.1068	.0506	.0280	.0205	.0173	.0135	.0072	.0058	.0032
.9000	.2993	.1632	.0827	.0407	.0183	.0113	.0098	.0072	.0032	.0018	.0039

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	21.69	25.70	243.02	102.55	32.12	349.88	229.20	107.67	310.87	155.19
.0615	14.15	60.82	216.81	46.72	259.75	174.76	49.74	235.42	253.22	104.44
.1462	6.15	187.78	159.75	358.13	144.66	324.46	216.81	171.72	59.24	315.16
.2583	6.95	199.17	138.59	345.60	177.13	308.64	145.37	18.20	354.86	256.46
.3881	15.08	225.14	155.07	12.88	235.74	271.17	146.69	24.13	310.24	194.67
.5238	13.97	219.18	129.15	.56	232.93	153.33	109.92	342.43	294.41	177.26
.6536	4.75	199.98	71.97	313.68	180.96	48.36	278.21	154.36	28.36	249.62
.7657	9.12	208.83	92.38	334.44	205.38	78.22	313.47	224.39	40.12	185.37
.8504	356.07	197.08	52.09	297.14	174.96	47.63	277.17	187.17	57.75	269.73
.9000	355.68	195.63	50.89	273.79	137.88	7.35	229.36	91.95	344.87	215.09

TABLE IV. - CONTINUED

MEAN ANGLE = 14.00000 DEG FREQUENCY = 7.63092 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.2139	1.2220	1.0963	.3300	.2450	.1935	.0939	.0415	.0937	.0753	.0203
.0615	2.0549	.7418	.4900	.2380	.1395	.0764	.0653	.0335	.0263	.0390	.0308
.1462	2.1400	.6101	.1596	.1182	.0715	.0341	.0257	.0221	.0393	.0295	.0129
.2583	1.2438	.5225	.1135	.0474	.0332	.0264	.0365	.0178	.0201	.0250	.0065
.3881	.9393	.3383	.0635	.0186	.0219	.0154	.0104	.0196	.0030	.0147	.0094
.5238	.7905	.2969	.0334	.0211	.0183	.0297	.0104	.0131	.0065	.0150	.0117
.6536	.5387	.1970	.0540	.0339	.0177	.0165	.0096	.0075	.0017	.0079	.0111
.7657	.4649	.3161	.0537	.0413	.0188	.0320	.0177	.0139	.0049	.0171	.0171
.8504	.3123	.2524	.0816	.0409	.0256	.0166	.0092	.0091	.0027	.0103	.0107
.9000	.3976	.2008	.0623	.0270	.0196	.0105	.0052	.0006	.0025	.0077	.0081

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	72.91	63.46	272.72	3.11	203.98	23.98	161.66	331.73	226.77	193.20
.0615	53.54	68.27	246.59	26.28	193.11	16.92	242.85	287.21	218.85	126.95
.1462	18.69	103.33	251.10	67.84	319.91	266.30	227.91	179.03	70.73	86.00
.2583	10.64	143.20	254.74	74.55	.23	255.28	145.16	184.62	59.25	296.67
.3881	16.47	140.75	260.21	344.77	194.74	226.90	123.22	28.02	31.75	290.19
.5238	16.41	180.20	245.27	307.82	181.11	111.37	99.90	37.15	7.23	279.97
.6536	6.54	249.06	225.09	174.28	129.05	70.47	24.40	314.60	333.45	235.75
.7657	11.84	236.17	238.73	213.25	153.17	85.68	52.16	356.90	.15	268.13
.8504	5.15	256.98	219.22	162.60	108.62	83.99	.31	197.67	328.48	226.82
.9000	1.75	248.02	222.44	152.27	79.98	14.58	3.49	353.48	313.78	215.72

MEAN ANGLE = 14.00000 DEG FREQUENCY = 9.88595 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.2844	1.2702	1.0593	.2946	.2411	.1978	.0925	.0280	.0850	.0719	.0182
.0615	2.1155	.8133	.4364	.1886	.1386	.0821	.0598	.0392	.0263	.0327	.0364
.1462	2.1848	.6805	.1452	.0654	.0635	.0325	.0297	.0235	.0506	.0427	.0075
.2583	1.2632	.5630	.1194	.0090	.0261	.0155	.0418	.0186	.0222	.0361	.0147
.3881	.9500	.3531	.0488	.0057	.0289	.0230	.0080	.0201	.0031	.0140	.0092
.5238	.8076	.3148	.0263	.0219	.0146	.0269	.0110	.0098	.0059	.0159	.0122
.6536	.5501	.2170	.0690	.0303	.0169	.0137	.0094	.0064	.0023	.0112	.0129
.7657	.4871	.3522	.0783	.0430	.0136	.0265	.0185	.0148	.0084	.0188	.0199
.8504	.3178	.2741	.0893	.0360	.0243	.0088	.0095	.0107	.0058	.0178	.0174
.9000	.4187	.2152	.0687	.0201	.0150	.0087	.0084	.0026	.0039	.0108	.0121

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	68.95	64.59	277.72	.94	204.16	38.72	171.37	332.45	225.85	154.48
.0615	47.76	71.46	245.30	19.00	191.94	31.37	262.41	255.16	204.81	116.58
.1462	16.27	125.04	245.04	56.33	331.07	249.73	226.66	176.88	69.01	73.37
.2583	11.37	159.71	213.05	31.52	11.06	252.71	140.95	187.55	66.85	311.06
.3881	20.97	147.05	251.72	329.39	182.18	213.79	126.94	33.92	59.21	322.19
.5238	21.39	215.10	229.05	311.49	176.34	112.52	106.71	75.13	21.42	280.34
.6536	7.22	249.79	208.71	163.03	122.40	102.05	36.40	347.43	342.79	244.96
.7657	13.54	247.77	216.45	184.87	151.22	109.58	63.38	22.23	347.87	254.39
.8504	5.18	249.58	225.85	167.80	118.86	46.06	8.21	57.92	336.52	236.21
.9000	2.09	246.86	213.67	158.93	108.65	69.64	331.59	36.58	313.82	219.19

TABLE IV. - CONCLUDED

MEAN ANGLE = 14.00000 DEG FREQUENCY = 14.11506 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.1923	1.3387	1.0163	.1972	.3010	.1637	.0442	.0914	.0462	.0067	.0359
.0615	2.0821	.9119	.3793	.1534	.1411	.0797	.0240	.0135	.0240	.0155	.0224
.1462	2.1810	.7485	.0663	.0933	.0403	.0236	.0226	.0062	.0374	.0326	.0156
.2583	1.2815	.6248	.0847	.0361	.0118	.0100	.0271	.0170	.0197	.0327	.0119
.3881	.9651	.4007	.0408	.0081	.0223	.0214	.0174	.0195	.0056	.0191	.0156
.5238	.8191	.3470	.0545	.0258	.0091	.0215	.0155	.0096	.0035	.0159	.0147
.6536	.5360	.2169	.0850	.0359	.0153	.0075	.0101	.0098	.0040	.0039	.0071
.7657	.4771	.3563	.1048	.0502	.0170	.0131	.0165	.0151	.0040	.0105	.0155
.8504	.2968	.2581	.0985	.0375	.0230	.0067	.0118	.0121	.0046	.0049	.0093
.9000	.4175	.2018	.0749	.0183	.0130	.0042	.0053	.0051	.0017	.0043	.0056

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	72.00	64.28	293.79	349.33	219.50	284.61	146.62	353.45	62.27	291.84
.0615	50.10	63.17	241.19	357.31	191.64	356.42	174.99	277.39	205.00	148.67
.1462	21.14	117.00	244.28	54.93	283.34	207.13	228.53	165.87	59.61	69.51
.2583	14.64	183.27	245.24	95.18	358.08	195.46	51.21	176.04	31.54	238.20
.3881	23.31	194.80	231.36	311.22	188.86	159.17	76.40	28.64	3.92	242.20
.5238	23.95	239.89	193.46	331.94	169.74	91.31	15.64	65.33	335.52	204.89
.6536	10.74	243.62	179.63	107.92	89.27	48.12	309.91	188.77	300.75	161.35
.7657	17.44	247.30	187.46	106.84	120.43	60.34	331.37	209.72	325.74	187.97
.8504	4.93	243.77	184.56	108.82	44.70	41.11	303.48	209.19	233.75	141.67
.9000	3.42	235.71	171.03	107.65	27.03	17.57	261.88	81.99	270.87	163.43

MEAN ANGLE = 14.00000 DEG FREQUENCY = 19.72610 CPS

HARMONIC AMPLITUDES

X/C	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
.0119	4.1742	1.4665	.9694	.1804	.2917	.1558	.0415	.0961	.0439	.0192	.0421
.0615	2.0773	1.0568	.3349	.1333	.1330	.0970	.0238	.0206	.0384	.0118	.0343
.1462	2.1806	.8182	.0027	.0853	.0297	.0171	.0059	.0118	.0307	.0286	.0105
.2583	1.2917	.6774	.0845	.0412	.0195	.0066	.0171	.0138	.0213	.0276	.0128
.3881	.9751	.4427	.0550	.0089	.0107	.0170	.0200	.0156	.0081	.0178	.0166
.5238	.8323	.3849	.0826	.0295	.0062	.0147	.0142	.0075	.0042	.0116	.0132
.6536	.5271	.2209	.0957	.0398	.0232	.0134	.0074	.0122	.0115	.0094	.0070
.7657	.4866	.3798	.1311	.0552	.0264	.0120	.0138	.0172	.0120	.0120	.0089
.8504	.2775	.2495	.1083	.0445	.0338	.0201	.0163	.0193	.0152	.0102	.0078
.9000	.4178	.2010	.0821	.0223	.0161	.0077	.0047	.0097	.0074	.0050	.0065

HARMONIC PHASE ANGLES

X/C	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
.0119	68.74	57.48	299.01	331.31	201.93	273.25	122.04	328.30	1.42	250.95
.0615	48.45	46.73	235.49	327.55	165.66	353.28	96.48	261.49	186.97	147.69
.1462	23.26	181.69	227.31	34.40	218.22	153.01	209.85	143.22	31.48	52.57
.2583	15.53	207.95	213.21	100.80	341.02	143.68	349.59	158.78	6.90	223.82
.3881	23.96	223.17	196.10	300.84	180.54	112.10	8.35	198.33	14.65	236.26
.5238	24.59	244.18	168.30	15.90	150.23	53.38	288.48	125.74	347.30	215.68
.6536	13.90	241.48	155.03	82.54	358.26	295.51	214.05	111.60	15.27	256.43
.7657	19.39	244.75	162.25	86.59	44.54	344.25	234.82	118.94	1.63	218.93
.8504	8.96	240.12	172.67	95.84	7.37	310.79	216.24	106.57	19.85	282.66
.9000	5.32	233.81	144.14	76.03	329.75	303.20	192.59	70.10	347.21	238.71

TABLE V

VALUES OF CONSTANT ANGULAR VELOCITY A

FOR RAMP CAM TIME HISTORIES

Nominal Frequency f_1 (Hz)	Forward		Backward	
	Upstroke	Downstroke	Upstroke	Downstroke
7.5	0.0021	-0.00105	0.00105	-0.0021
10.0	0.0028	-0.0014	0.0014	-0.0028
14.3	0.0040	-0.0020	0.0020	-0.0040
20.0	0.0056	-0.0028	0.0028	-0.0056

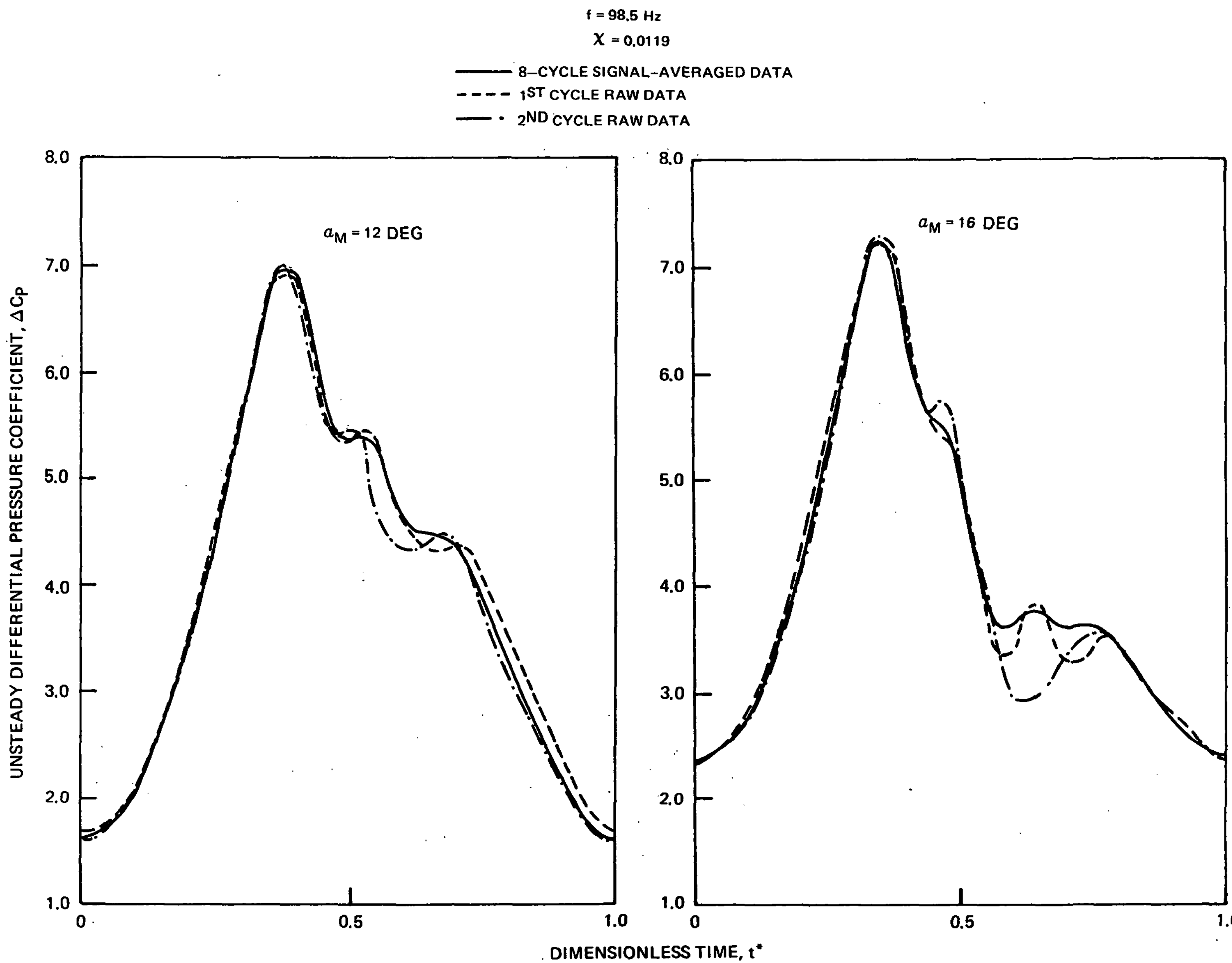


FIGURE 1. COMPARISON BETWEEN RAW DATA AND SIGNAL–AVERAGED DATA

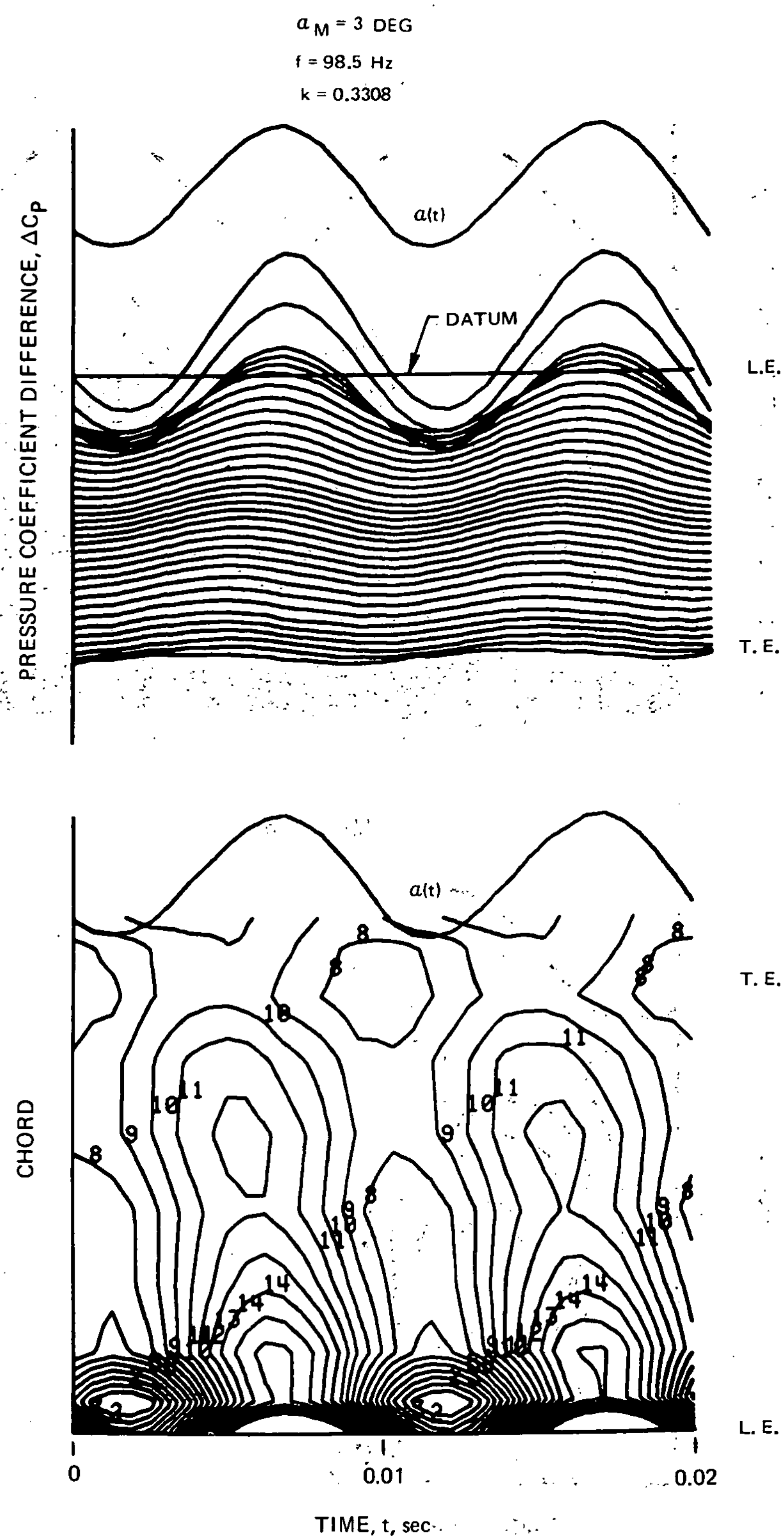


FIGURE 2. SAMPLE TIME HISTORY OF UNSTEADY PRESSURE DATA

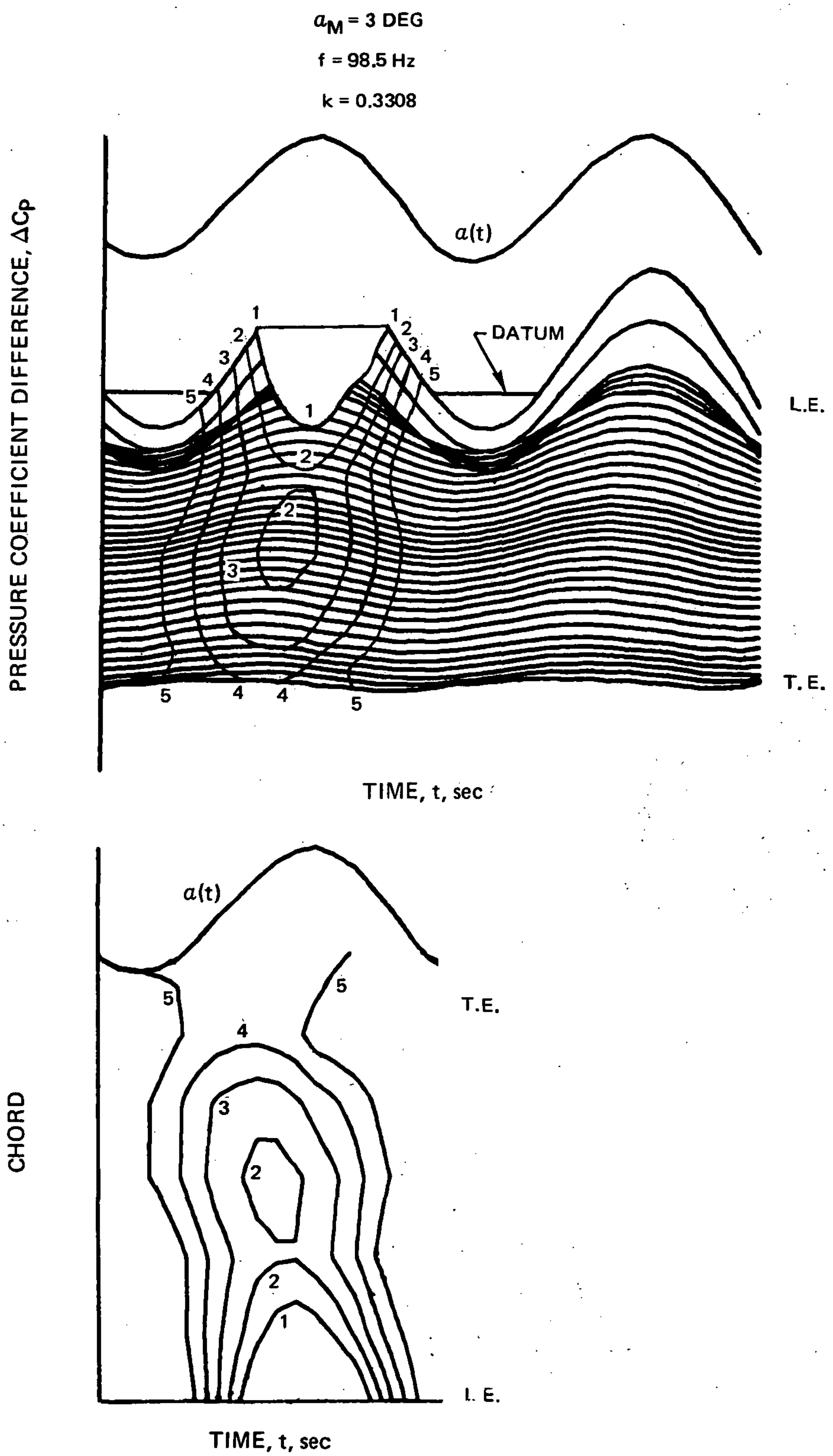


FIGURE 3. SCHEMATIC TO CLARIFY TIME HISTORY AND CONTOUR PLOTS

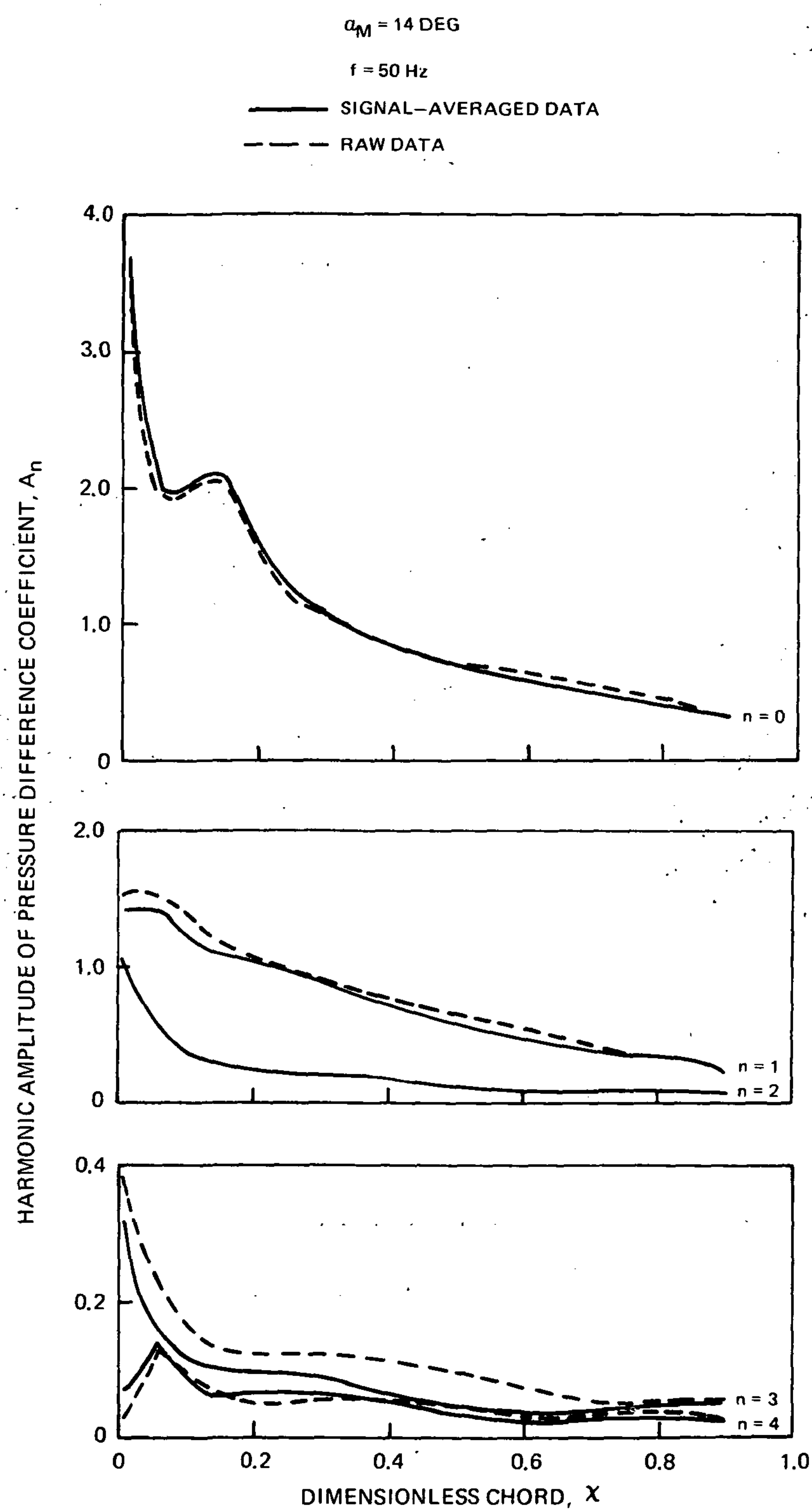


FIGURE 4. COMPARISON OF HARMONIC AMPLITUDES FOR SIGNAL–AVERAGED DATA AND RAW DATA

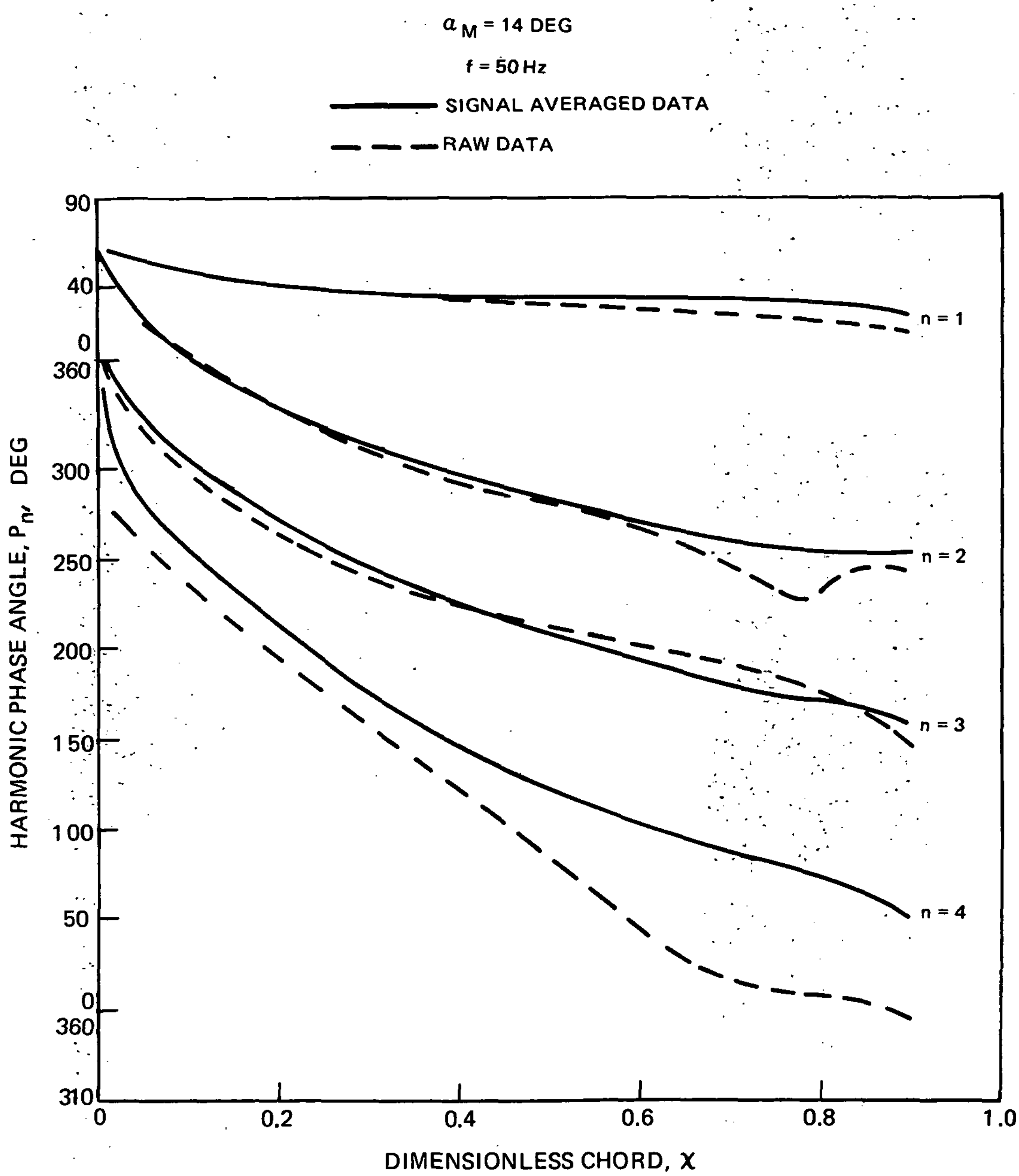


FIGURE 5. COMPARISON OF HARMONIC PHASE ANGLES FOR SIGNAL–AVERAGED DATA AND RAW DATA

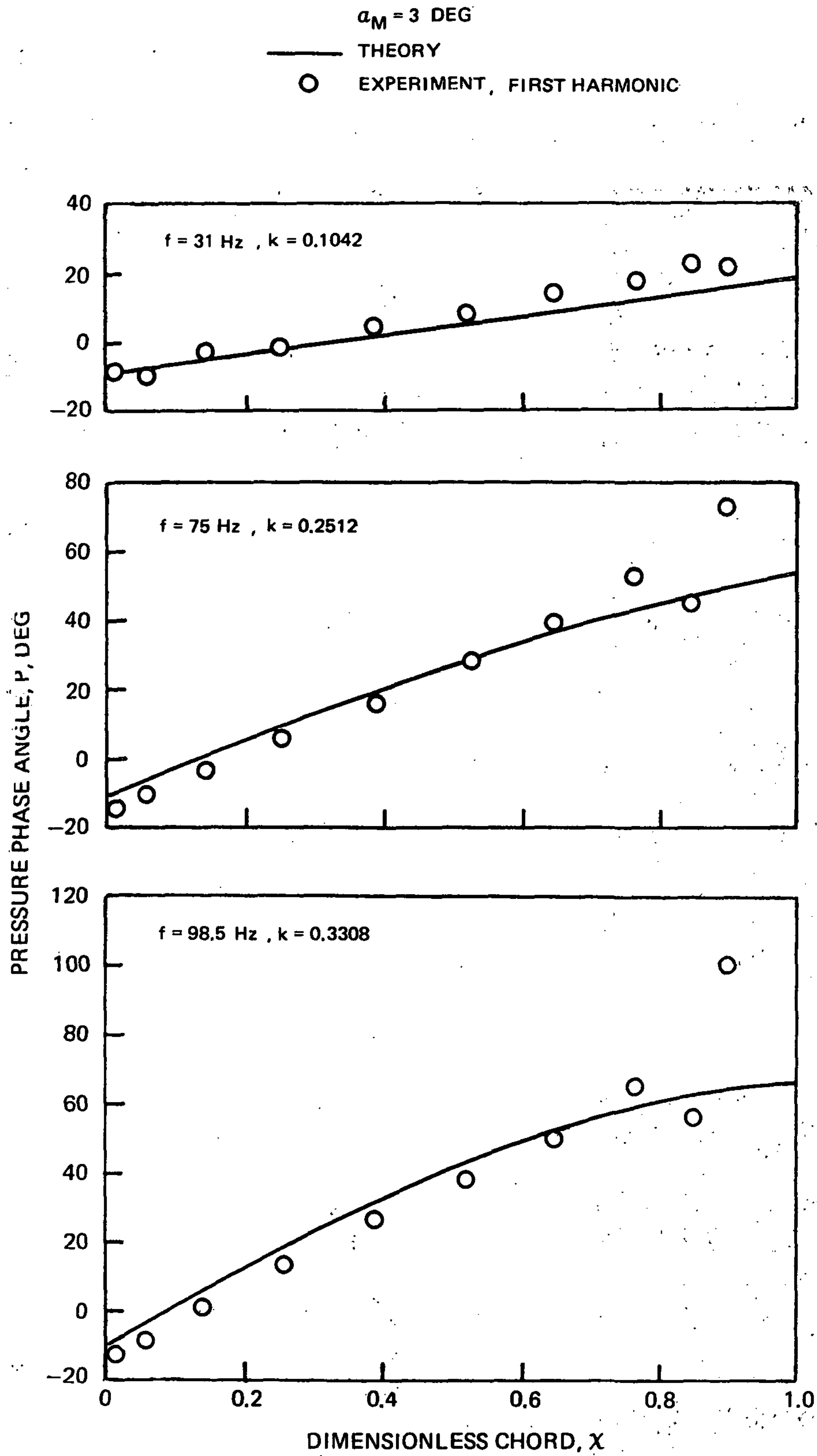


FIGURE COMPARISON OF PREDICTED AND MEASURED PRESSURE PHASE ANGLE AT LOW INCIDENCE

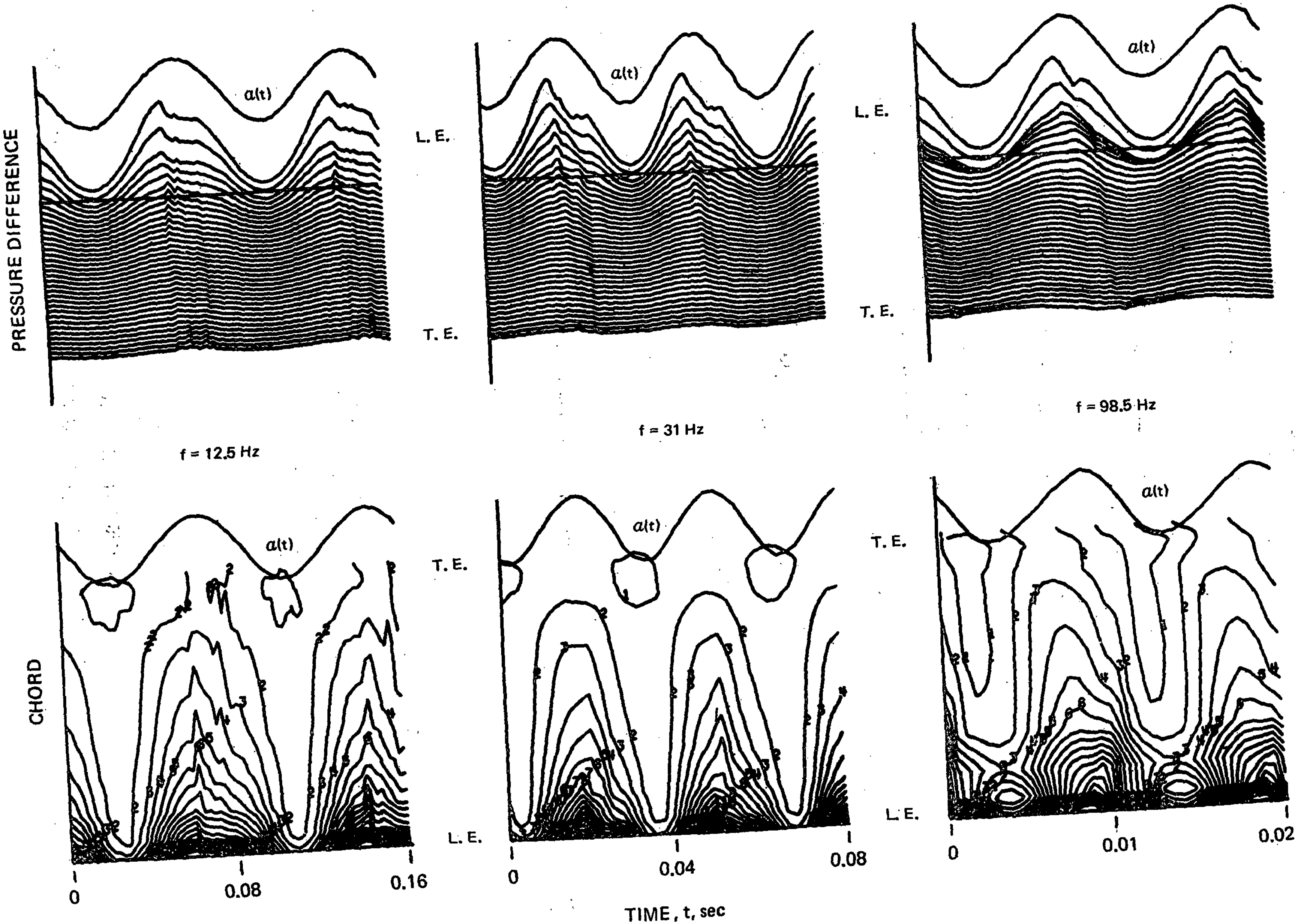
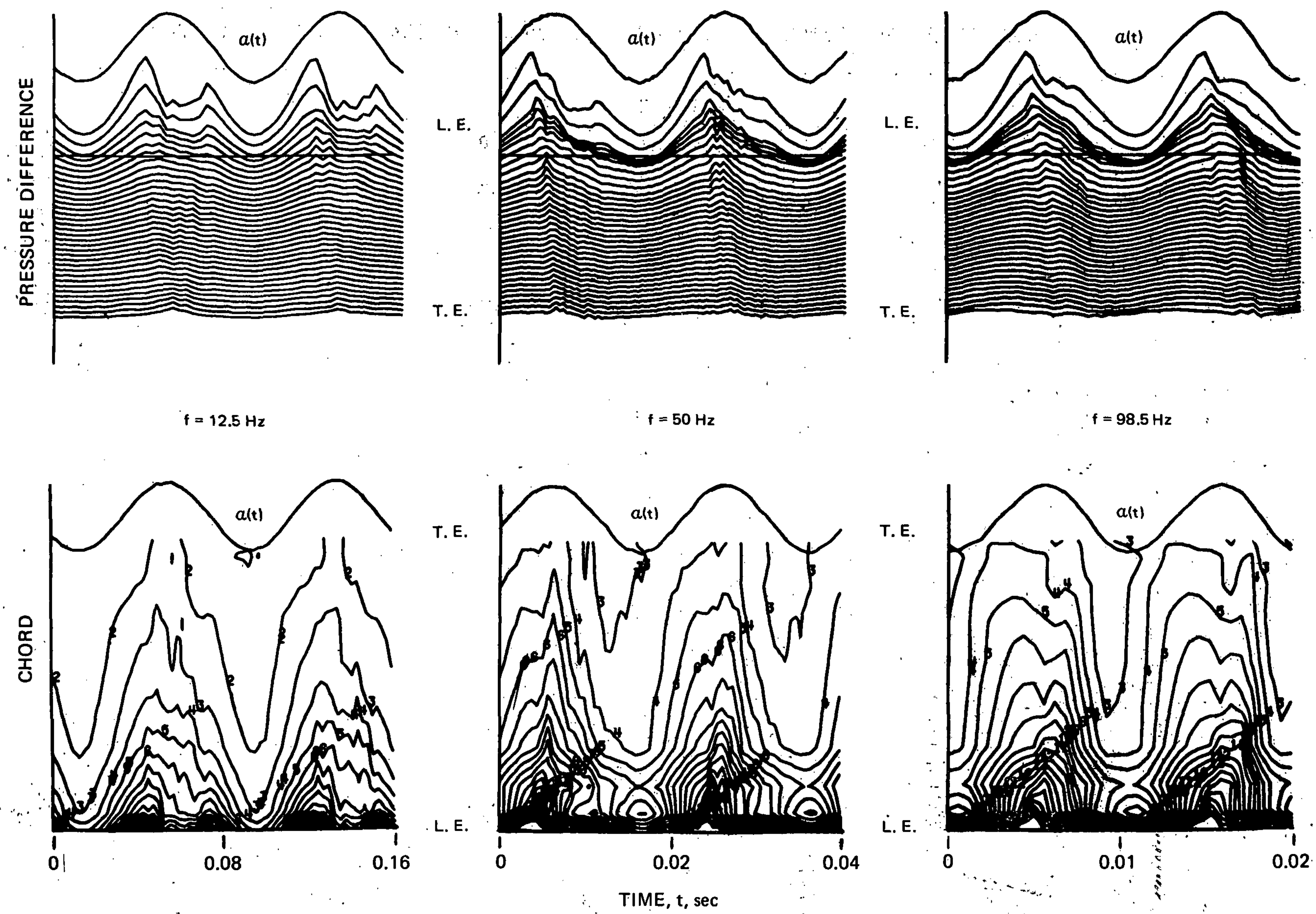


FIGURE 7. EFFECT OF FREQUENCY ON PRESSURE TIME HISTORIES AND CONTOURS AT $\alpha_M = 9$ DEG


PRESSURE DIFFERENCE
α(t)
L. E.
T. E.
α(t)
L. E.
T. E.
α(t)
f = 12.5 Hz
f = 50 Hz
f = 98.5 Hz
CHORD
α(t)
T. E.
L. E.
α(t)
T. E.
L. E.
α(t)
0
0.08
0.16
0
0.02
0.04
0
0.01
0.02
TIME, t, sec

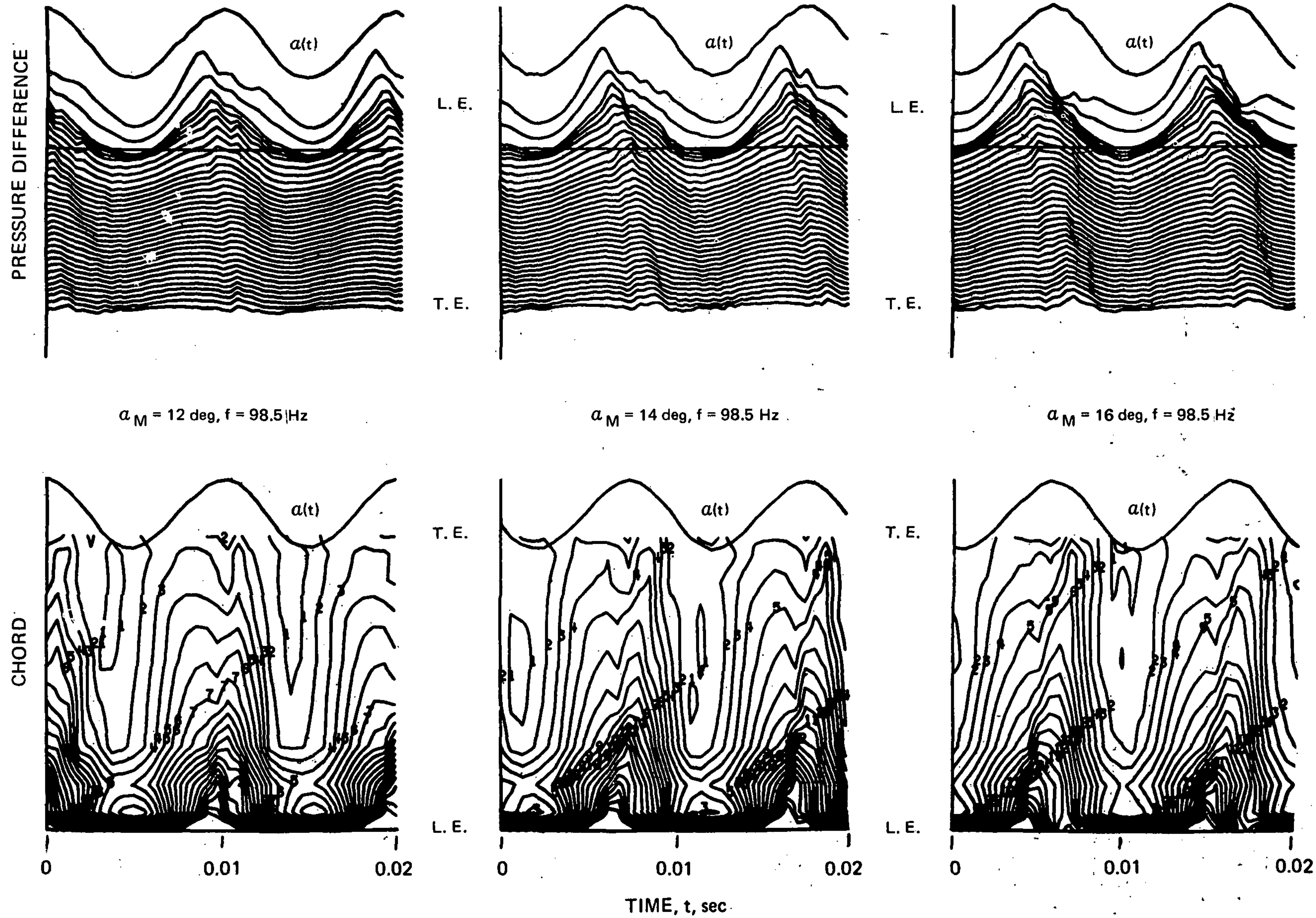


FIGURE 9. PERSISTENCE OF POTENTIAL FLOW BEHAVIOR AT HIGH FREQUENCY

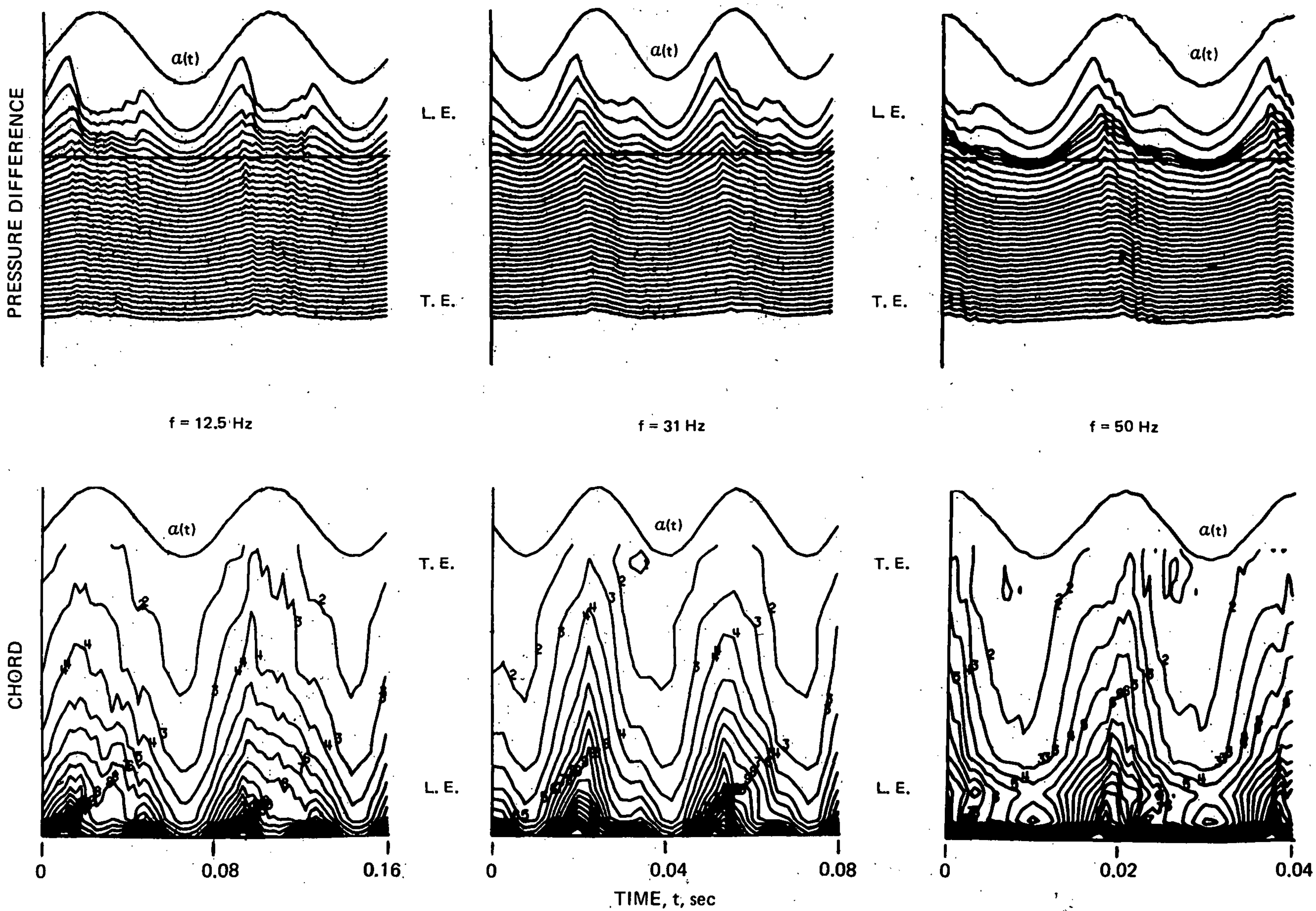


FIGURE 10. EFFECT OF FREQUENCY ON PRESSURE TIME HISTORIES AND CONTOURS AT $\alpha_M = 12$ DEG

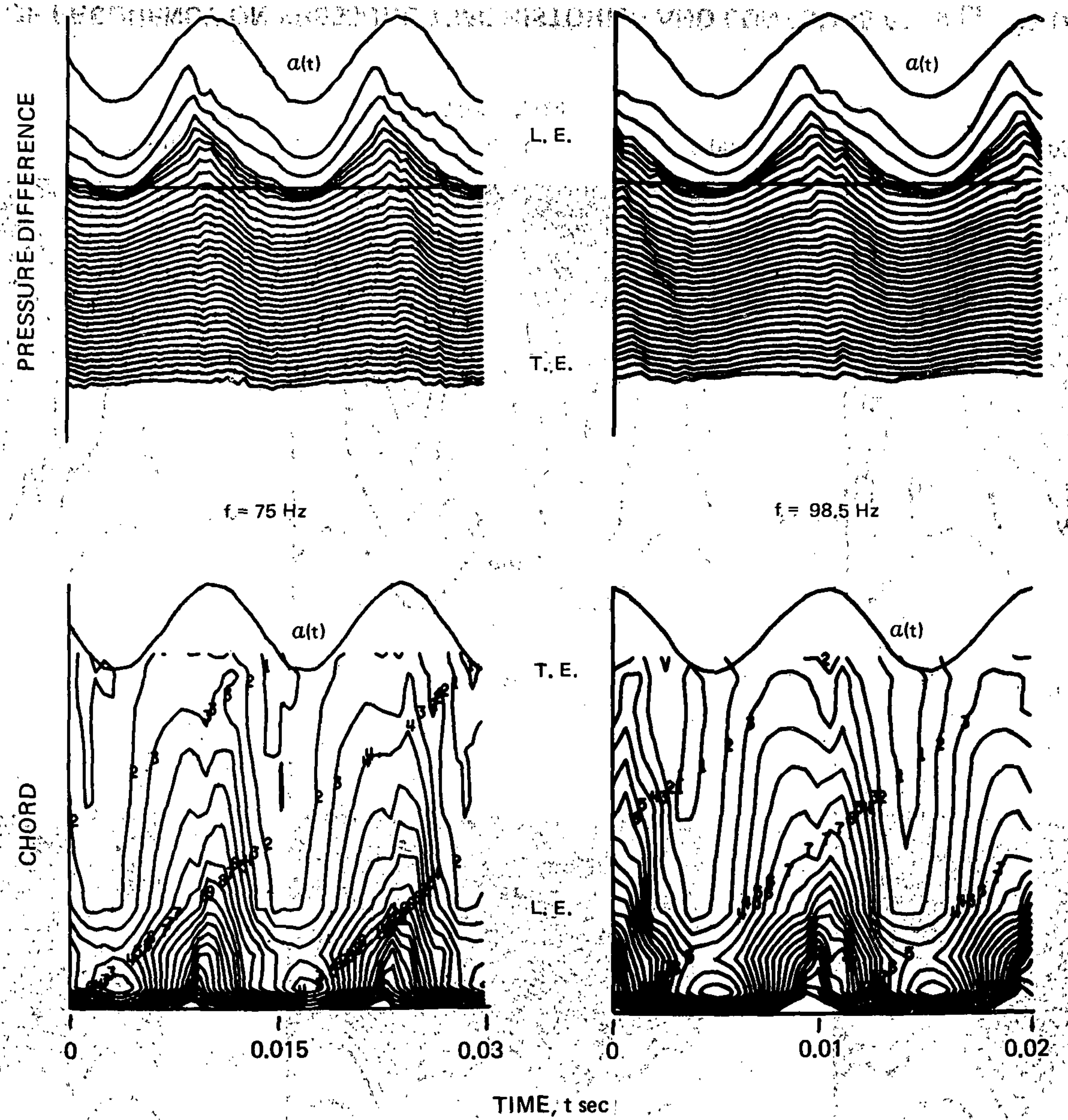


FIGURE 10, CONCLUDED

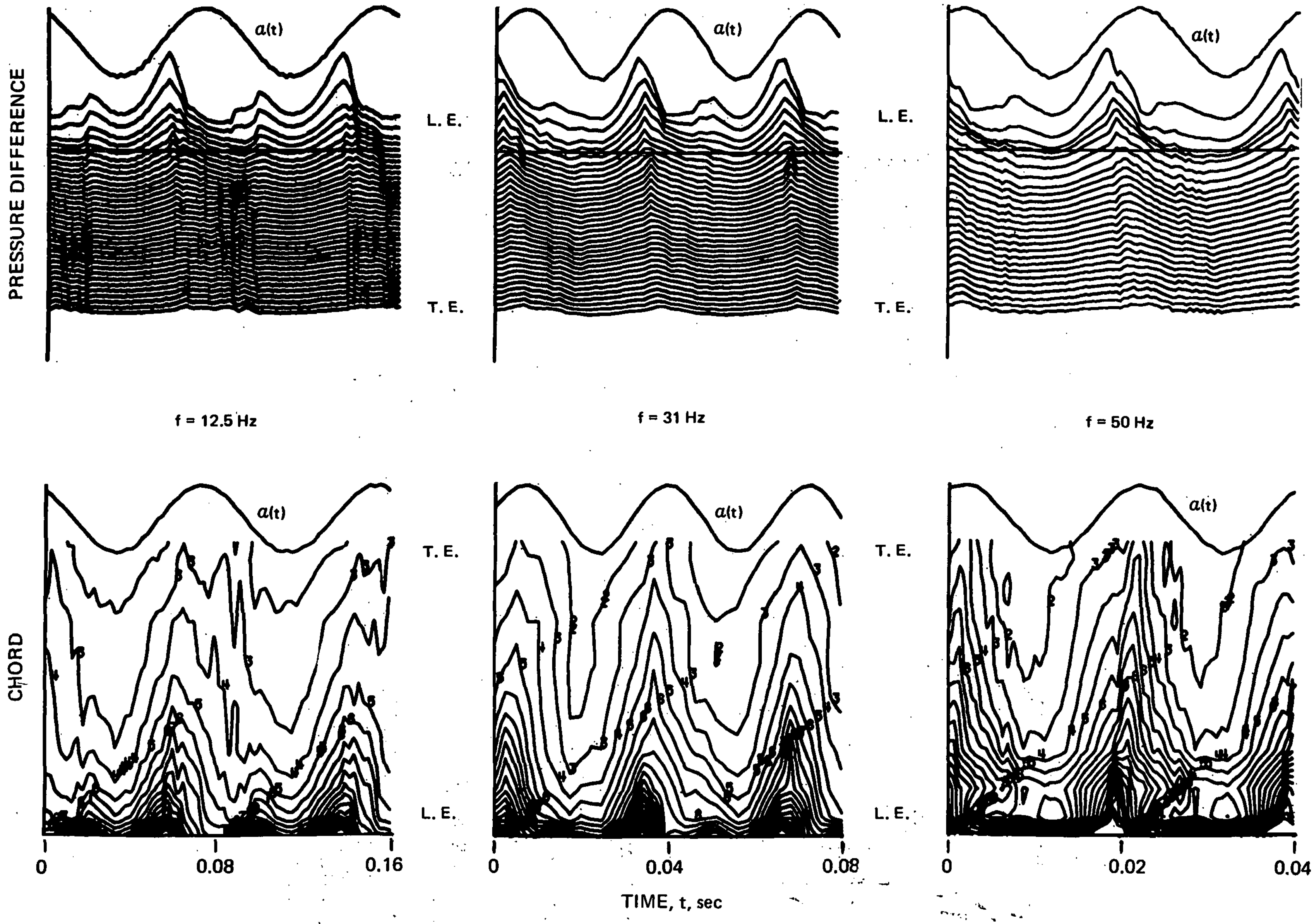


FIGURE 11. EFFECT OF FREQUENCY ON PRESSURE TIME HISTORIES AND CONTOURS AT $\alpha_M = 14$ DEG

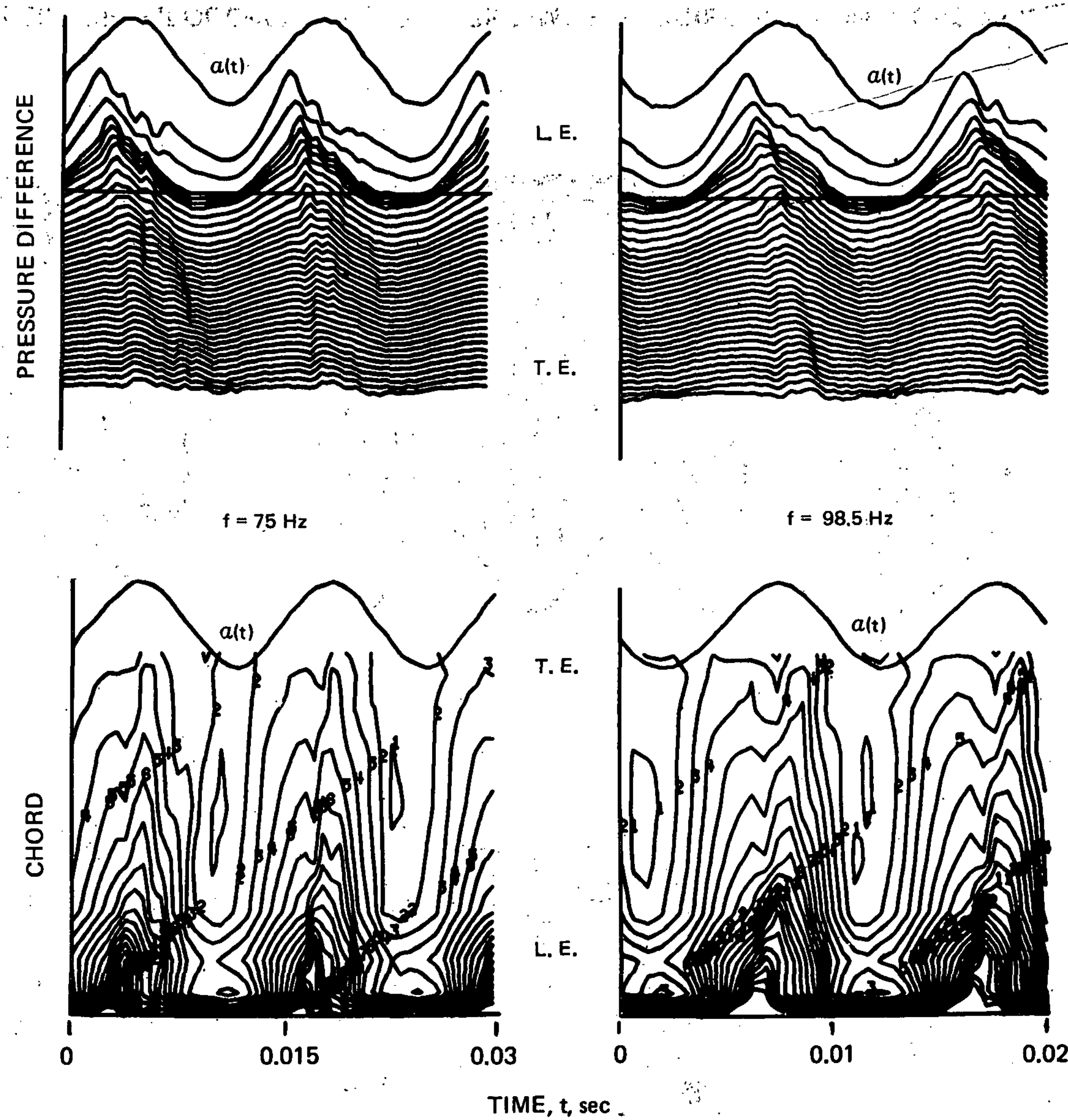


FIGURE 11. CONCLUDED

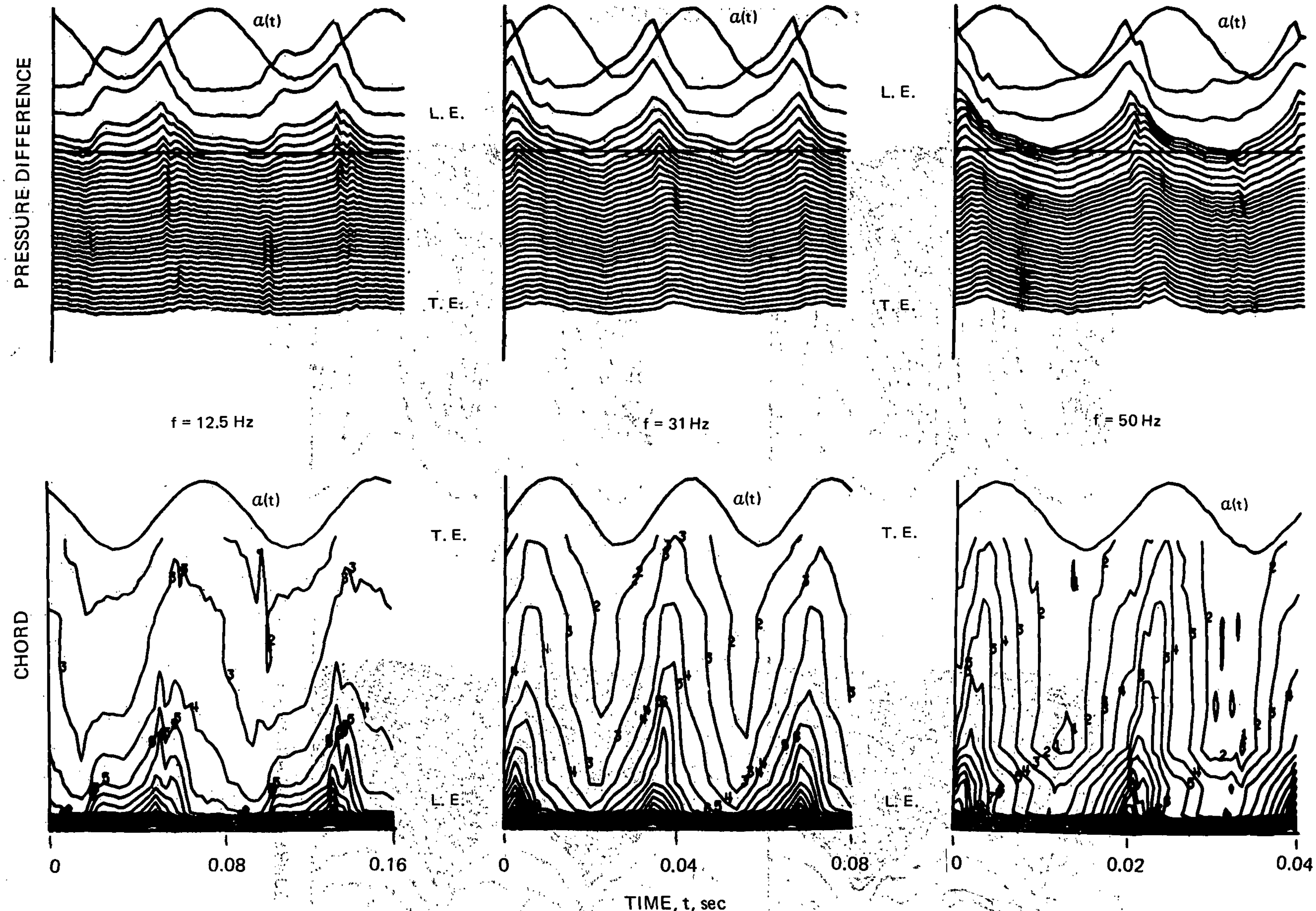


FIGURE 12. EFFECT OF FREQUENCY ON PRESSURE TIME HISTORIES AND CONTOURS AT α_M = 18 DEG

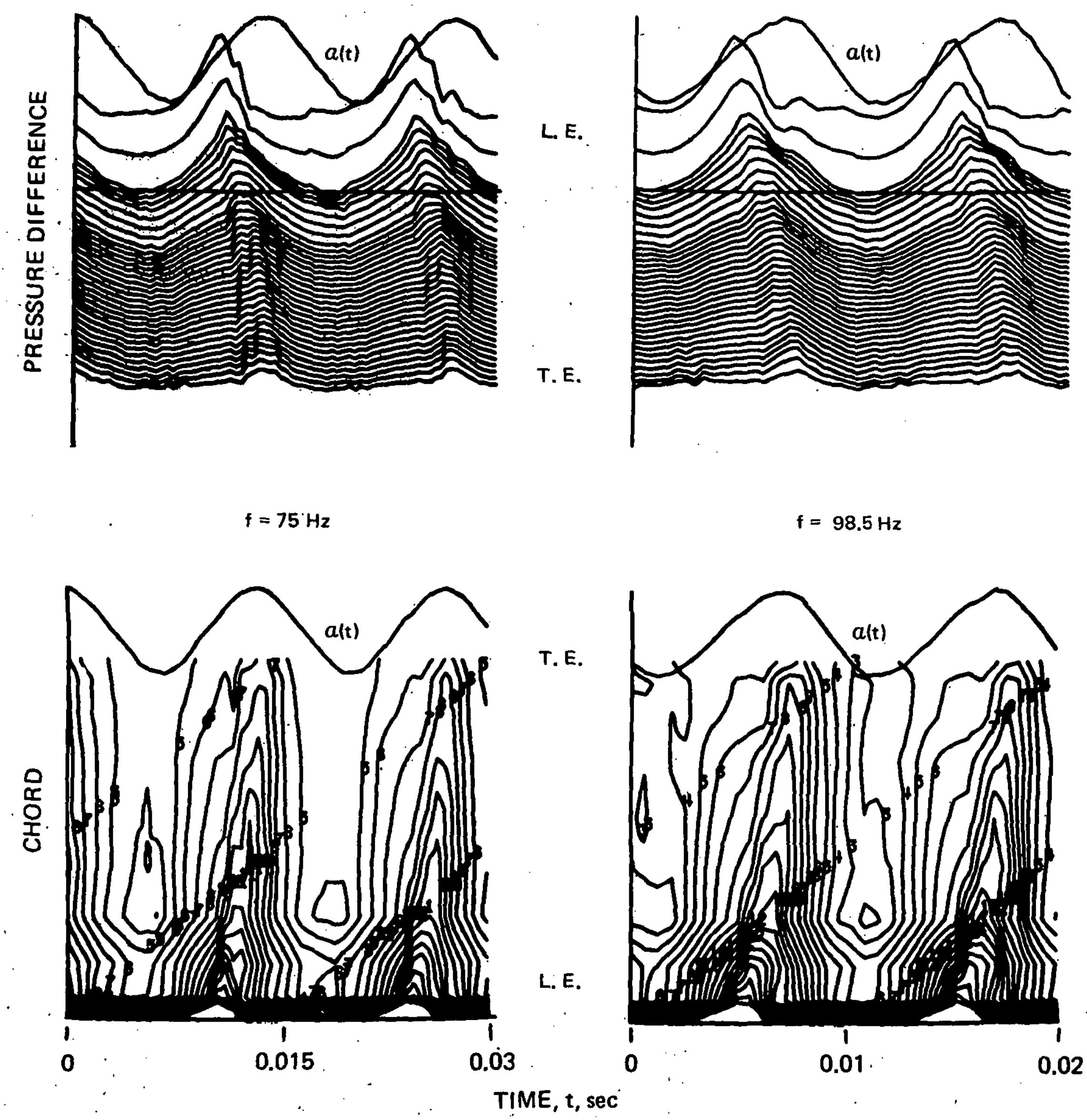


FIGURE 12. CONCLUDED

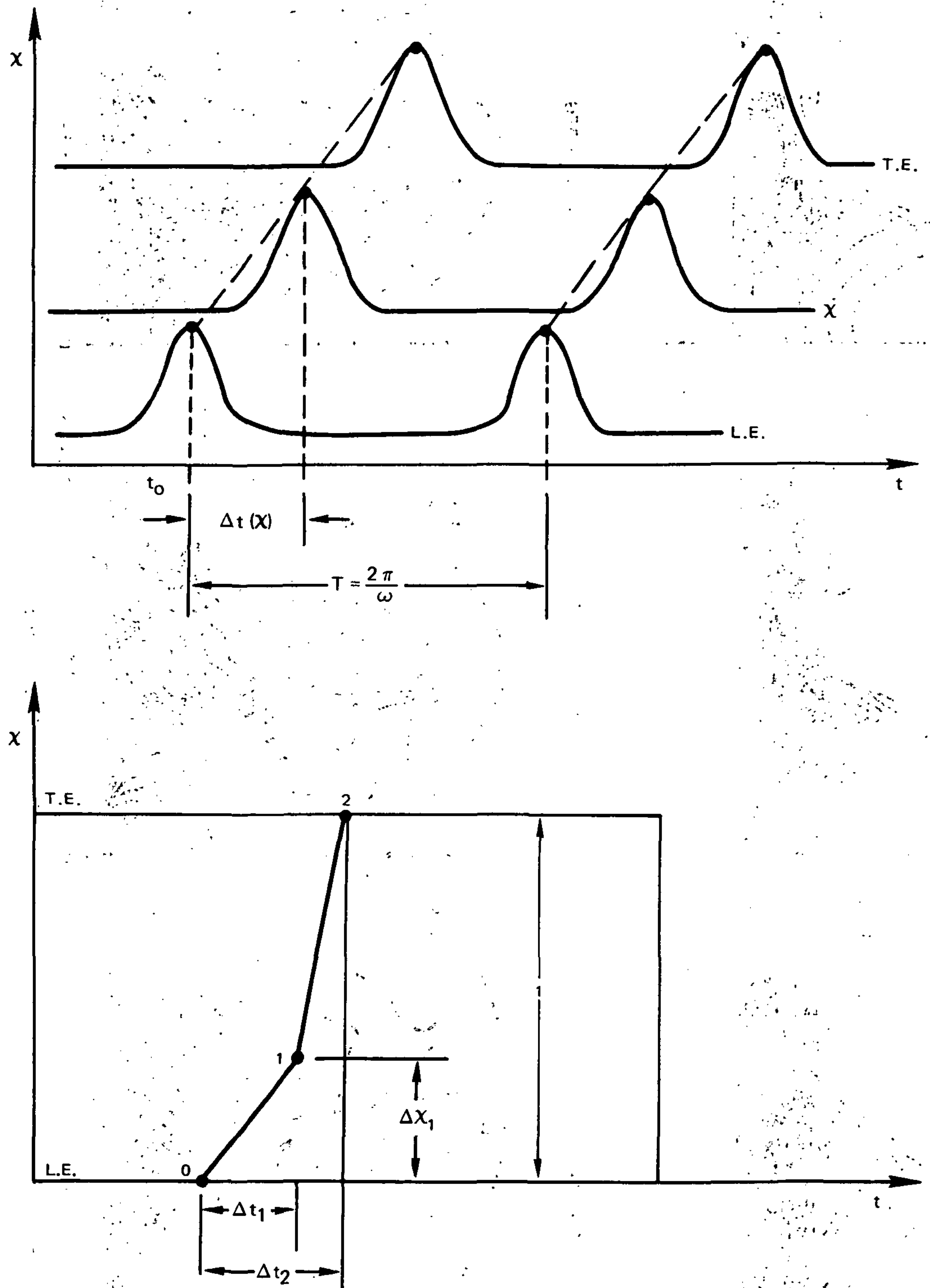


FIGURE 13. SCHEMATIC DIAGRAMS OF CHORDWISE PROPAGATION OF PRESSURE WAVE

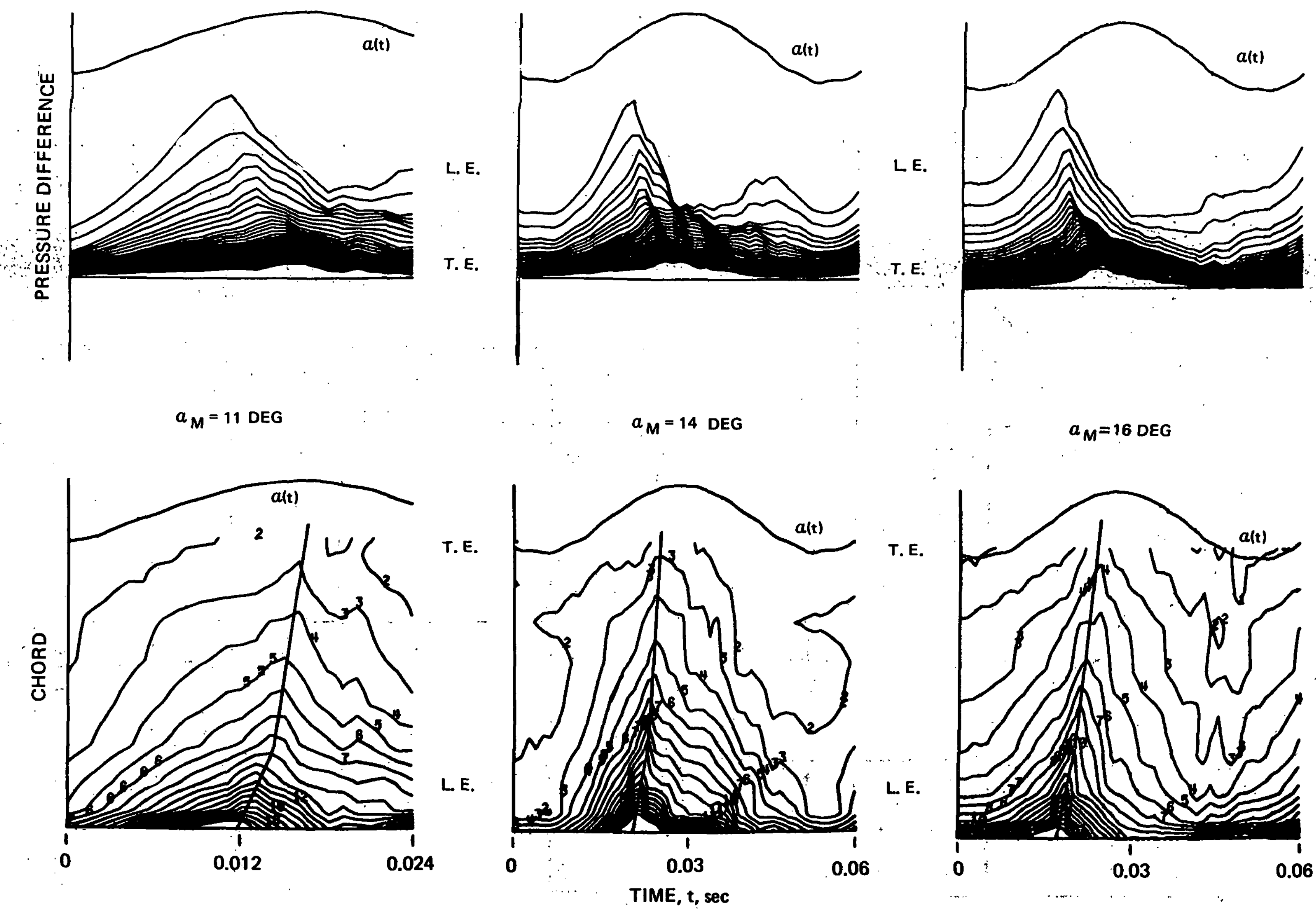


FIGURE 14. TIME HISTORIES AND CONTOUR PLOTS WITH SUPERPOSED RIDGE LINE LOCI FOR f = 31 Hz

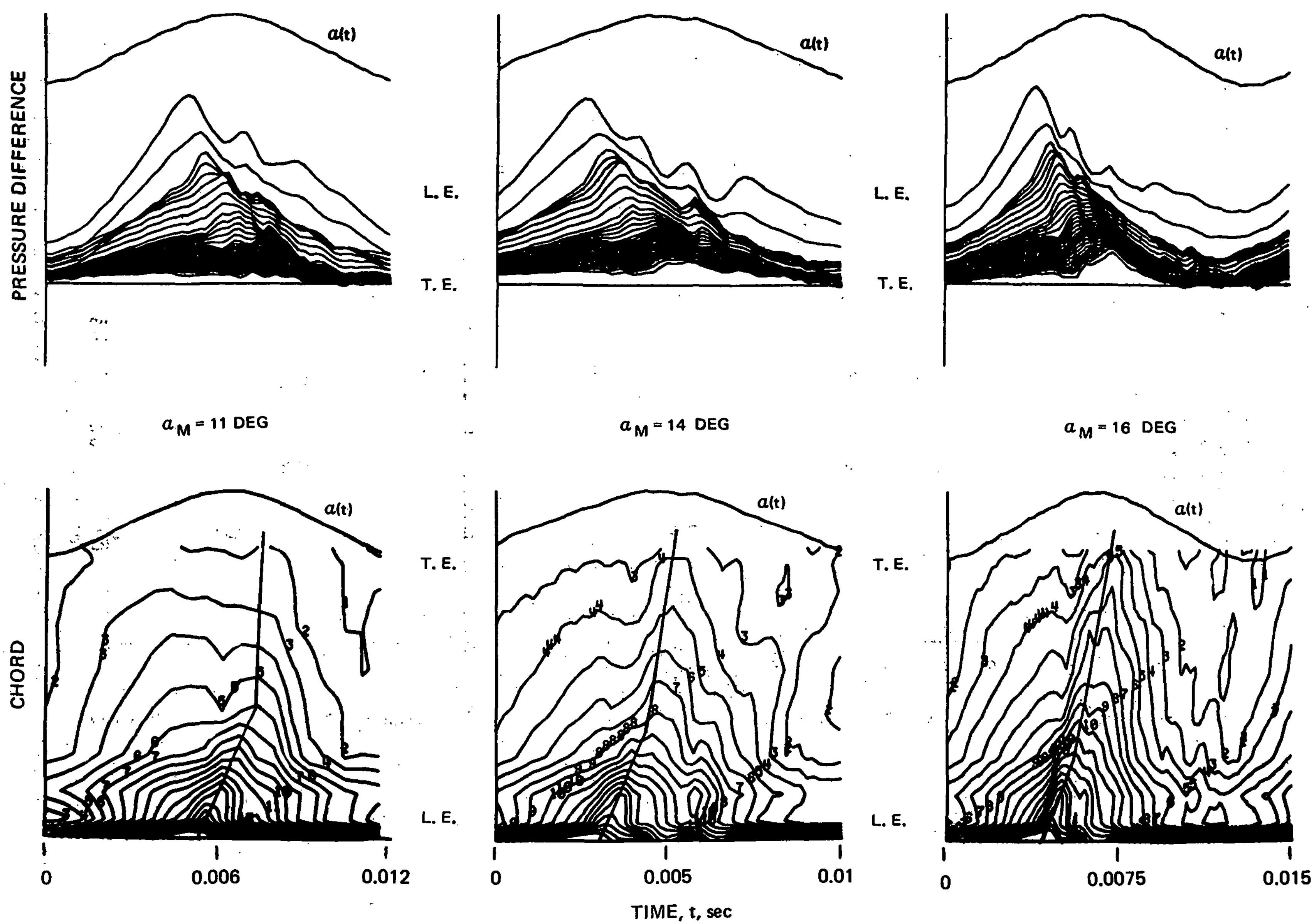


FIGURE 15. TIME HISTORIES AND CONTOUR PLOTS WITH SUPERPOSED RIDGE LINE LOCI FOR f = 75 Hz

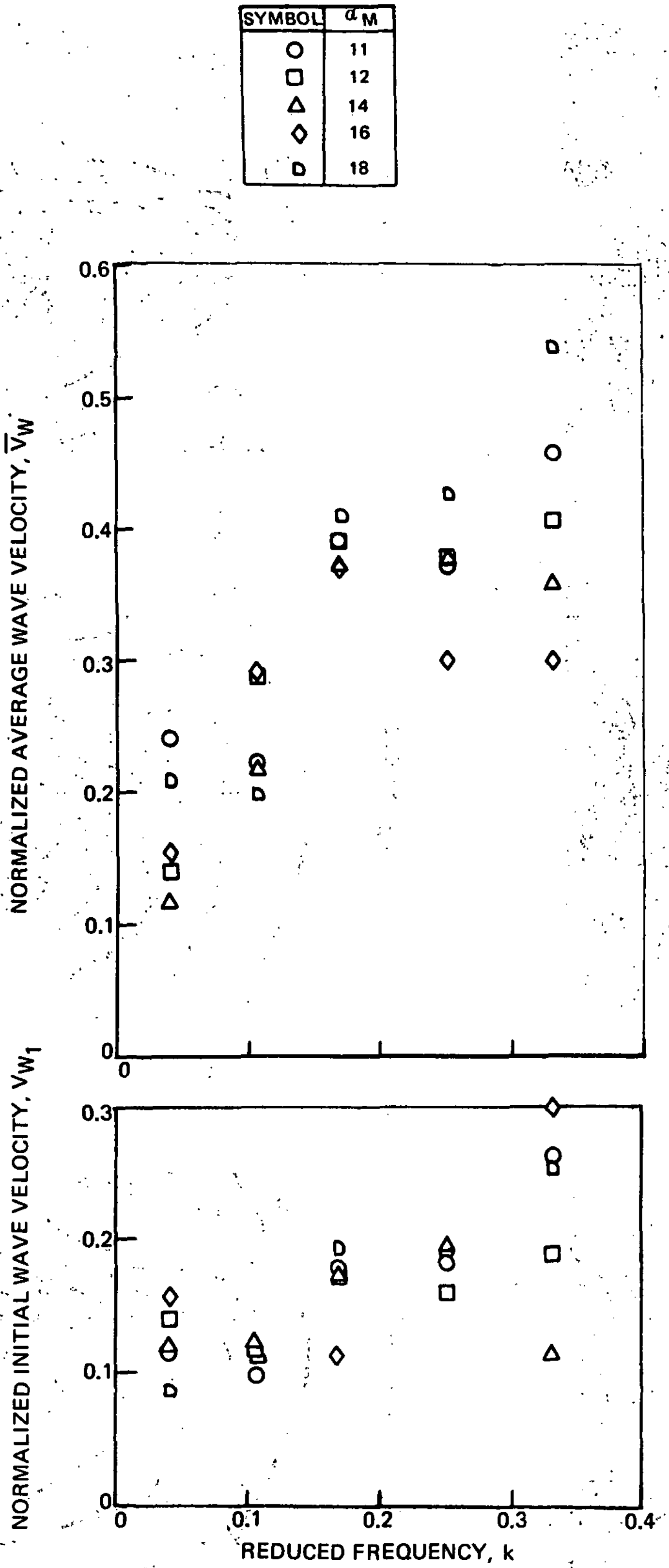


FIGURE 16. VARIATION OF NORMALIZED WAVE VELOCITIES WITH FREQUENCY

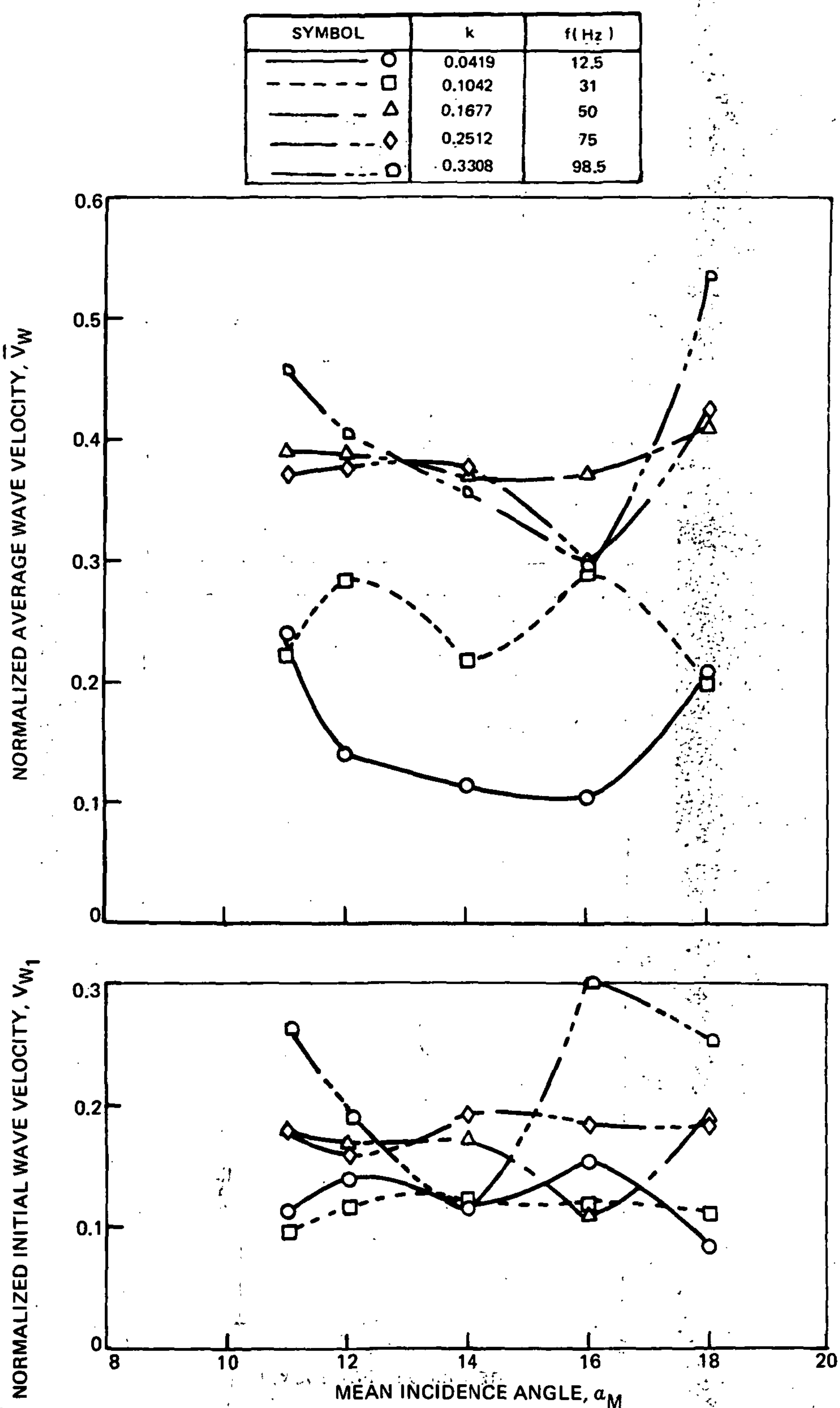


FIGURE 17. CROSSPLOT OF NORMALIZED WAVE VELOCITIES WITH MEAN INCIDENCE ANGLE

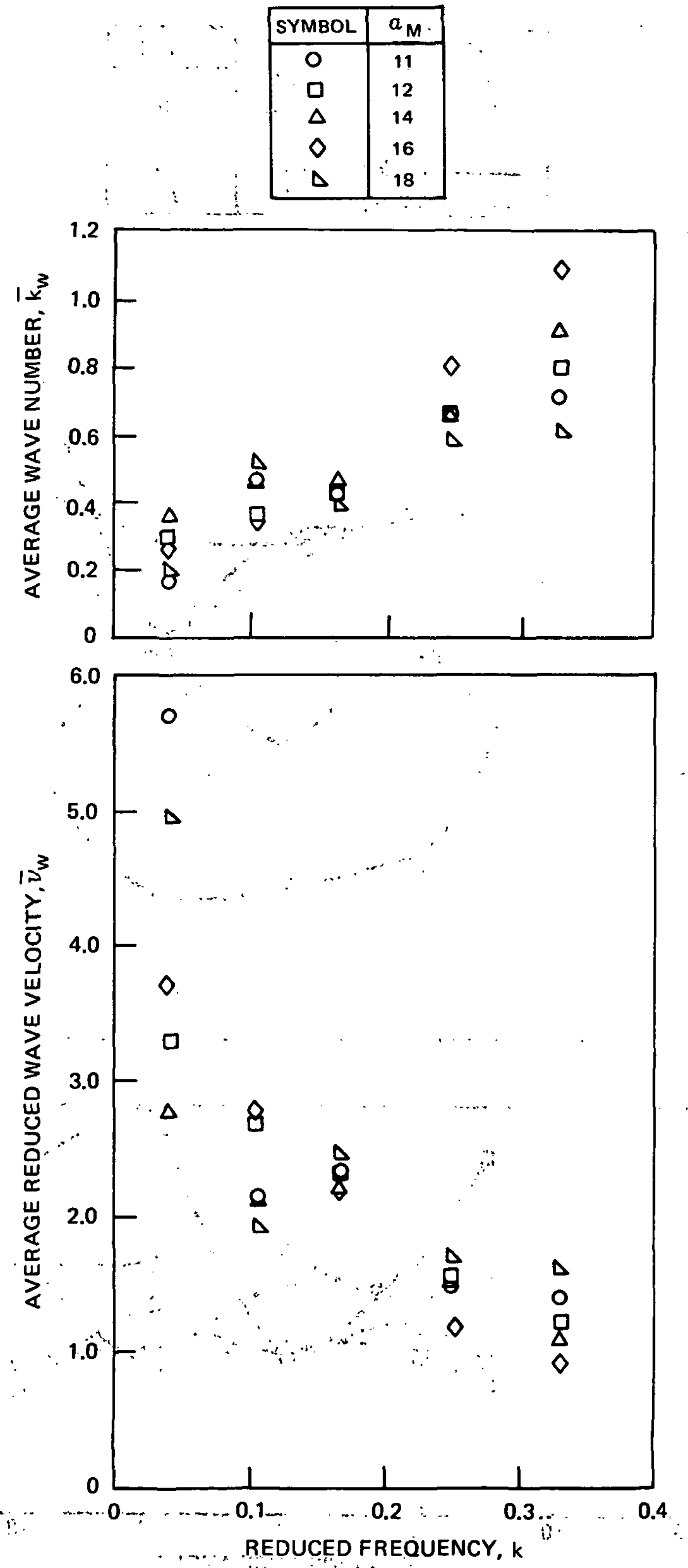


FIGURE 18. WAVE NUMBER AND REDUCED VELOCITY FOR AVERAGE WAVE PROPAGATION

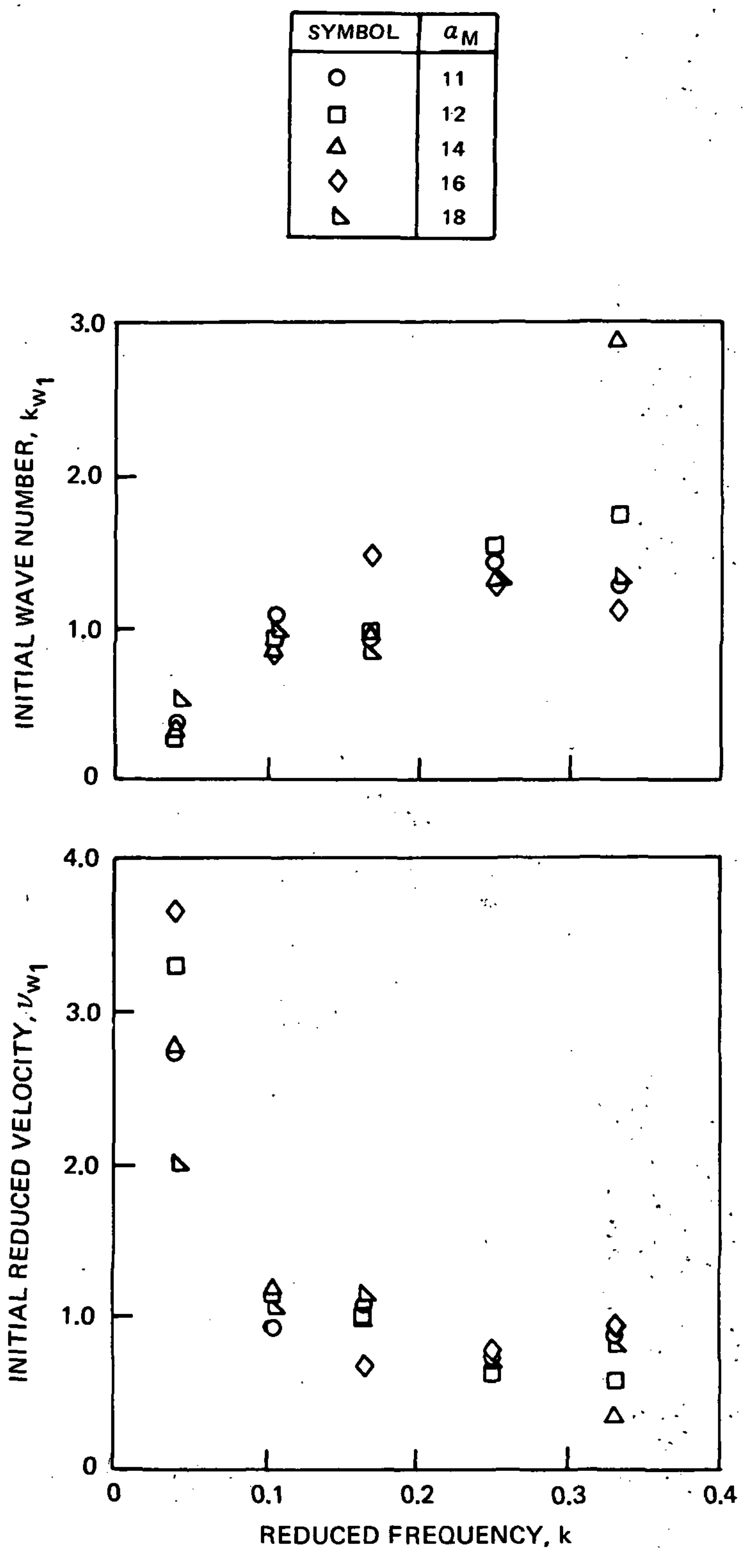


FIGURE 19. WAVE NUMBER AND REDUCED VELOCITY FOR INITIAL WAVE PROPAGATION

SYMBOL	AIRFOIL	M	f	α_M	$\bar{\alpha}$	REF (FIG.)
○	VERTOL 13006 – 0.7	0.2	24	12	5	21 (24)
□	VERTOL 13006 – 0.7	0.2	48	12.5	5	22 (12)
△	VERTOL 13006 – 0.7	0.3	12	10	5	21 (20)
◇	VERTOL 13006 – 0.7	0.3	68	10	5	21 (22)
D	VERTOL 13006 – 0.7	0.4	48	10	5	21 (25)
◖	VERTOL 23010 – 1.58	0.4	94.3	12.5	5.7	8 (33)
●	NACA 0012	0.4	89.3	12.2	5.9	8 (40)
■	NACA 0006	0.2	12	7.5	5	22 (6)
▲	NACA 0006	0.4	48	10	5	22 (11)
◆	NACA 0006	0.6	72	10	5	22 (10)
◖	NACA 0012	≈0.1	≈1	15	14	20

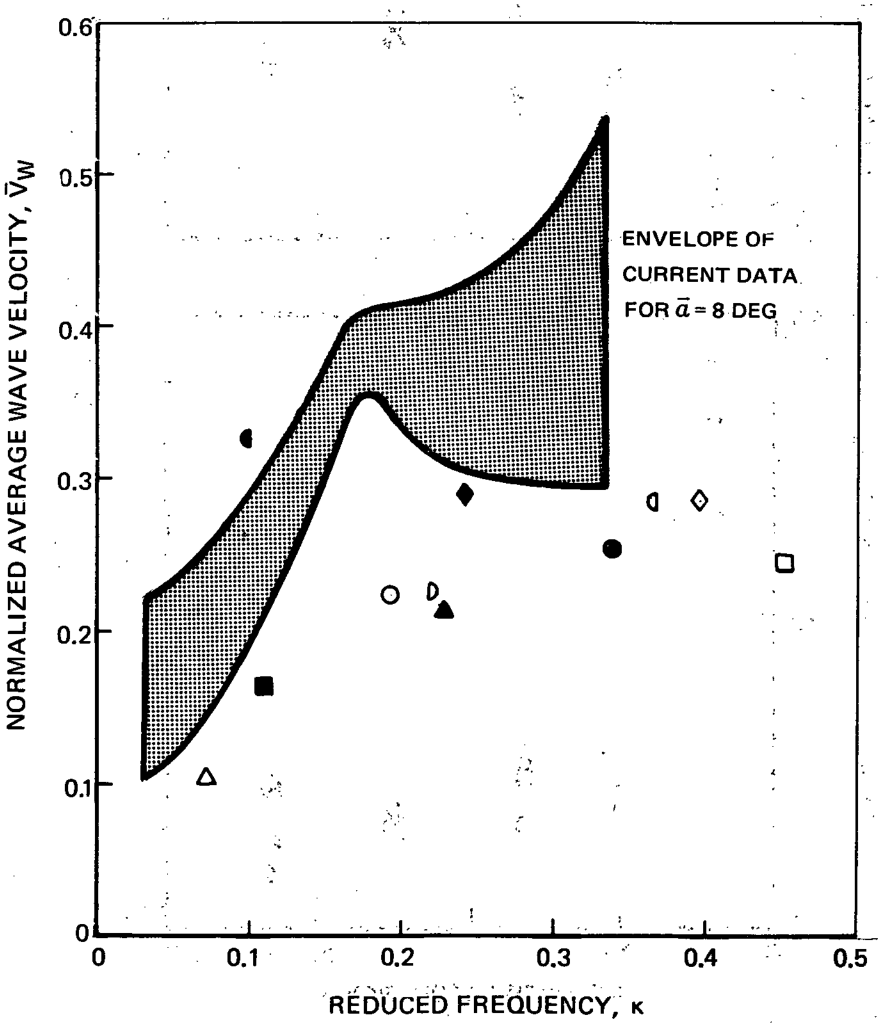


FIGURE 20. WAVE VELOCITY COMPARISONS

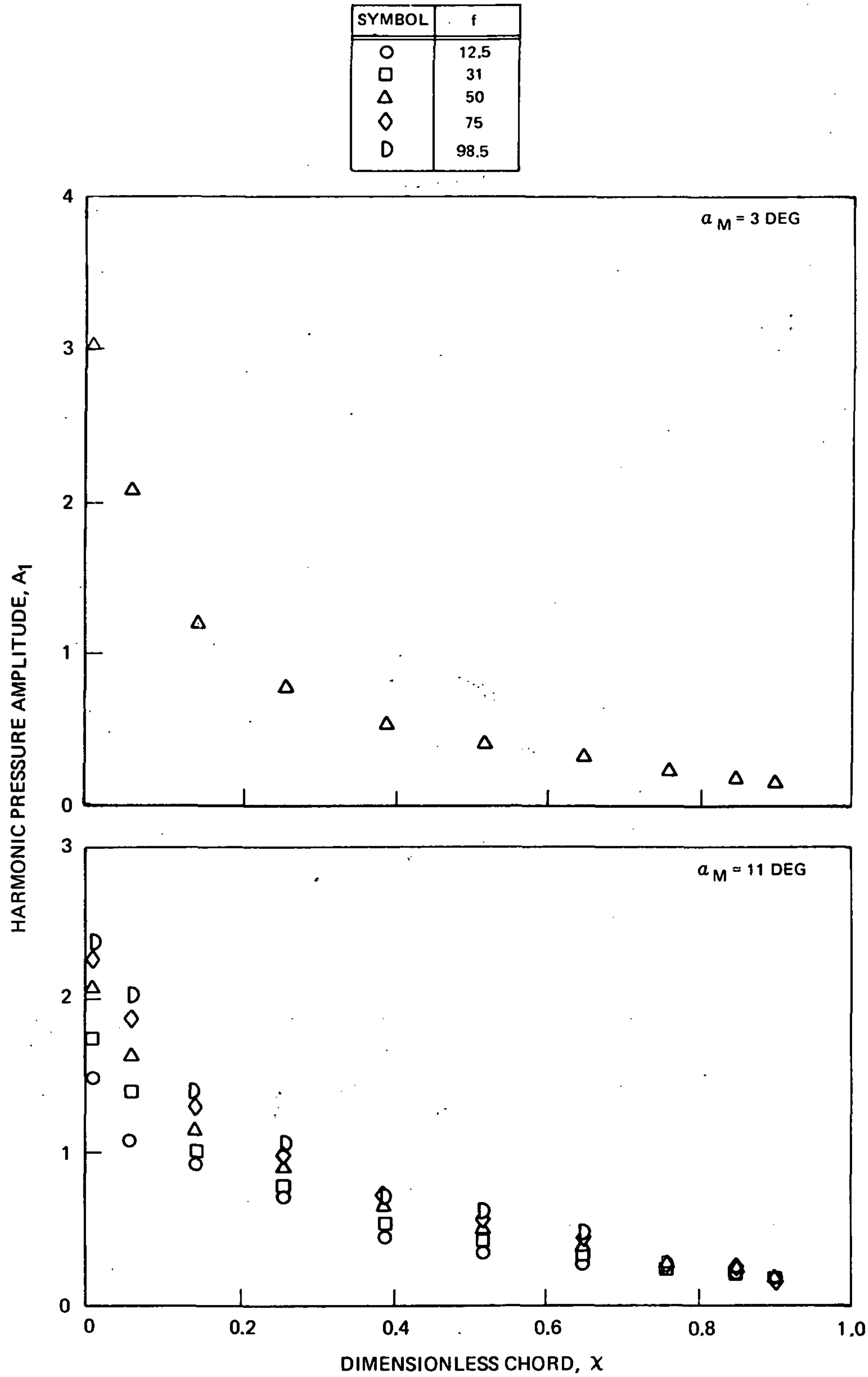


FIGURE 21. CHORDWISE DISTRIBUTION OF FIRST HARMONIC PRESSURE AMPLITUDE

SYMBOL	f
○	12.5
□	31
△	50
◇	75
D	98.5

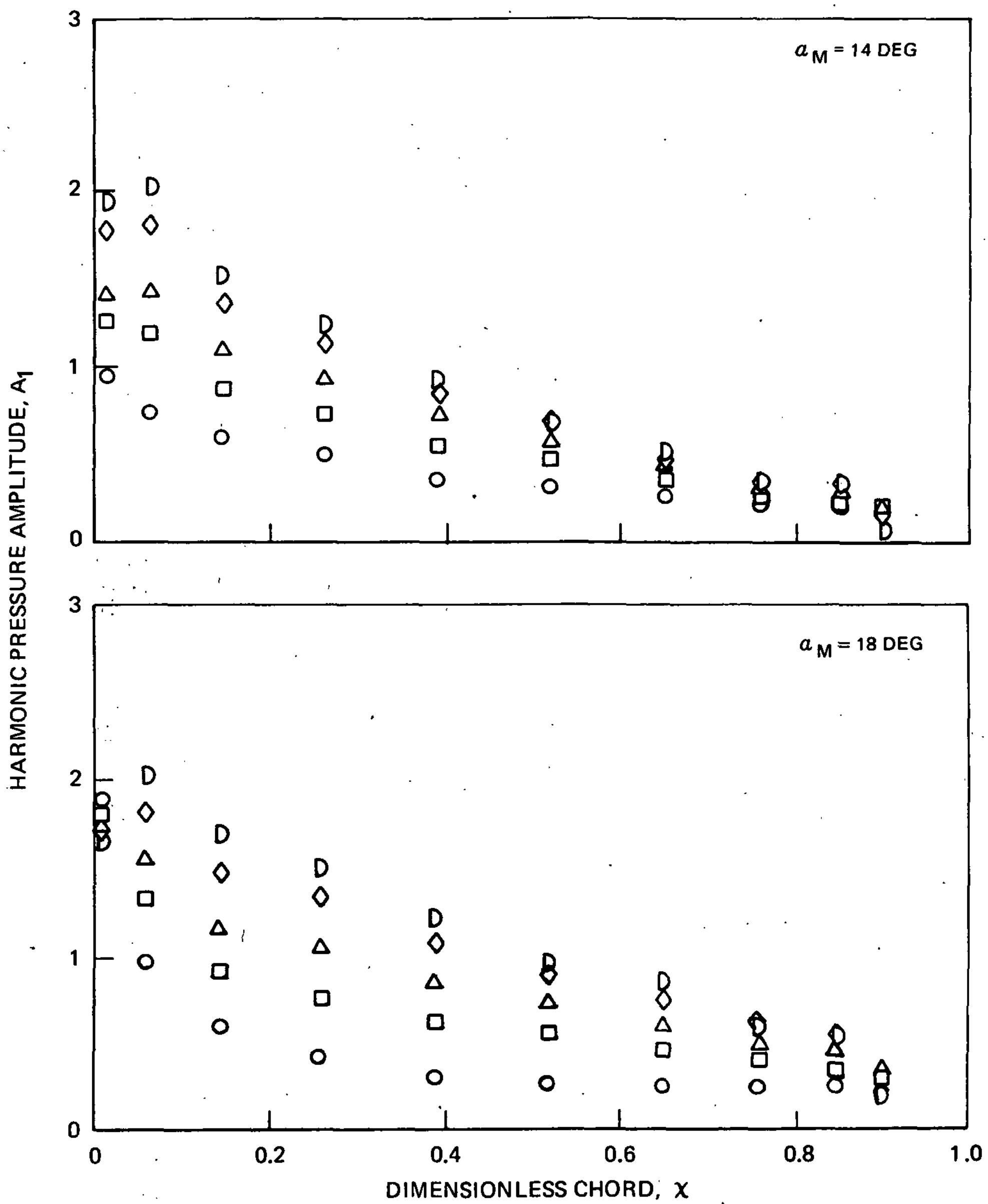


FIGURE 21. CONCLUDED

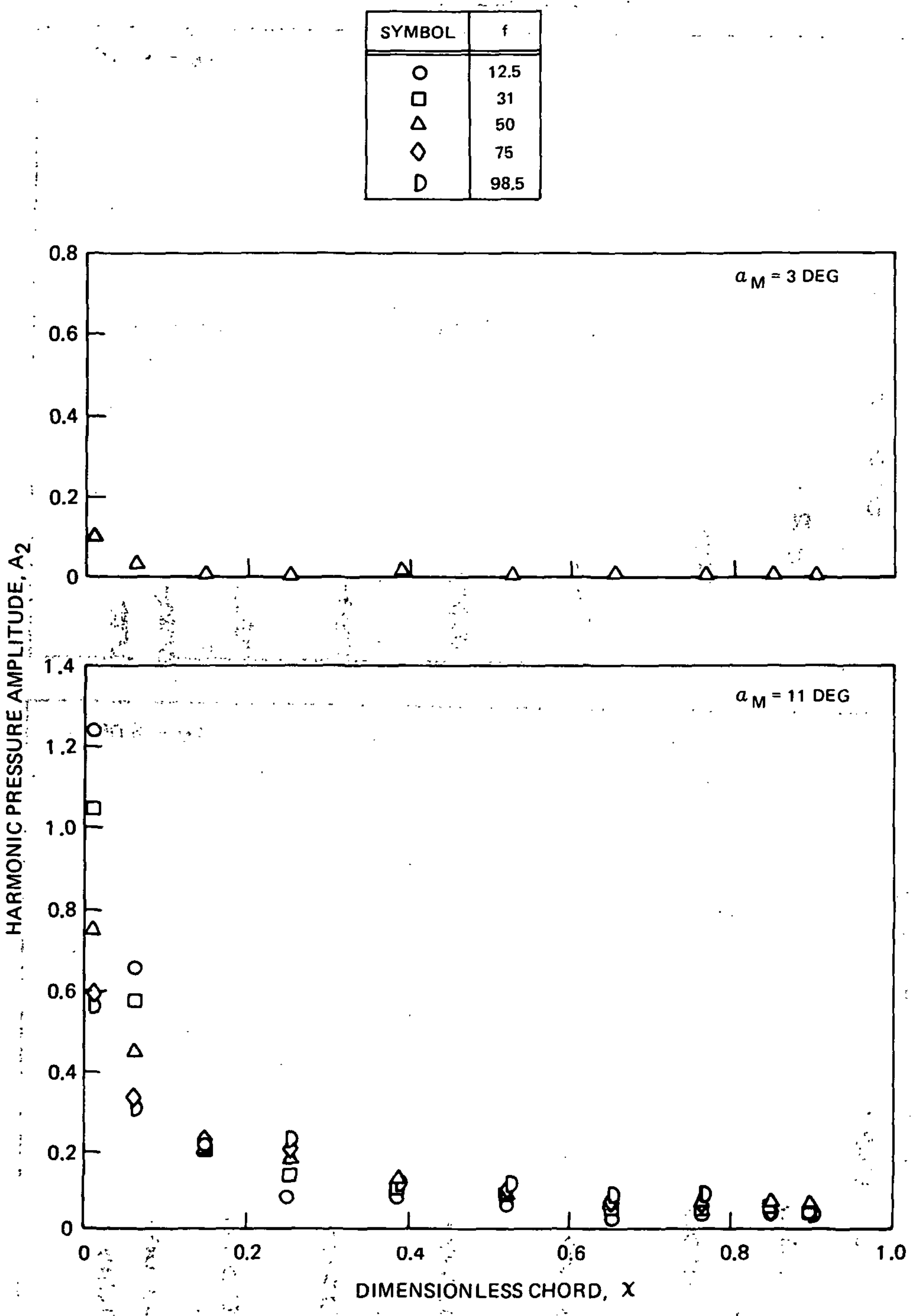


FIGURE 22. CHORDWISE DISTRIBUTION OF SECOND HARMONIC PRESSURE AMPLITUDE

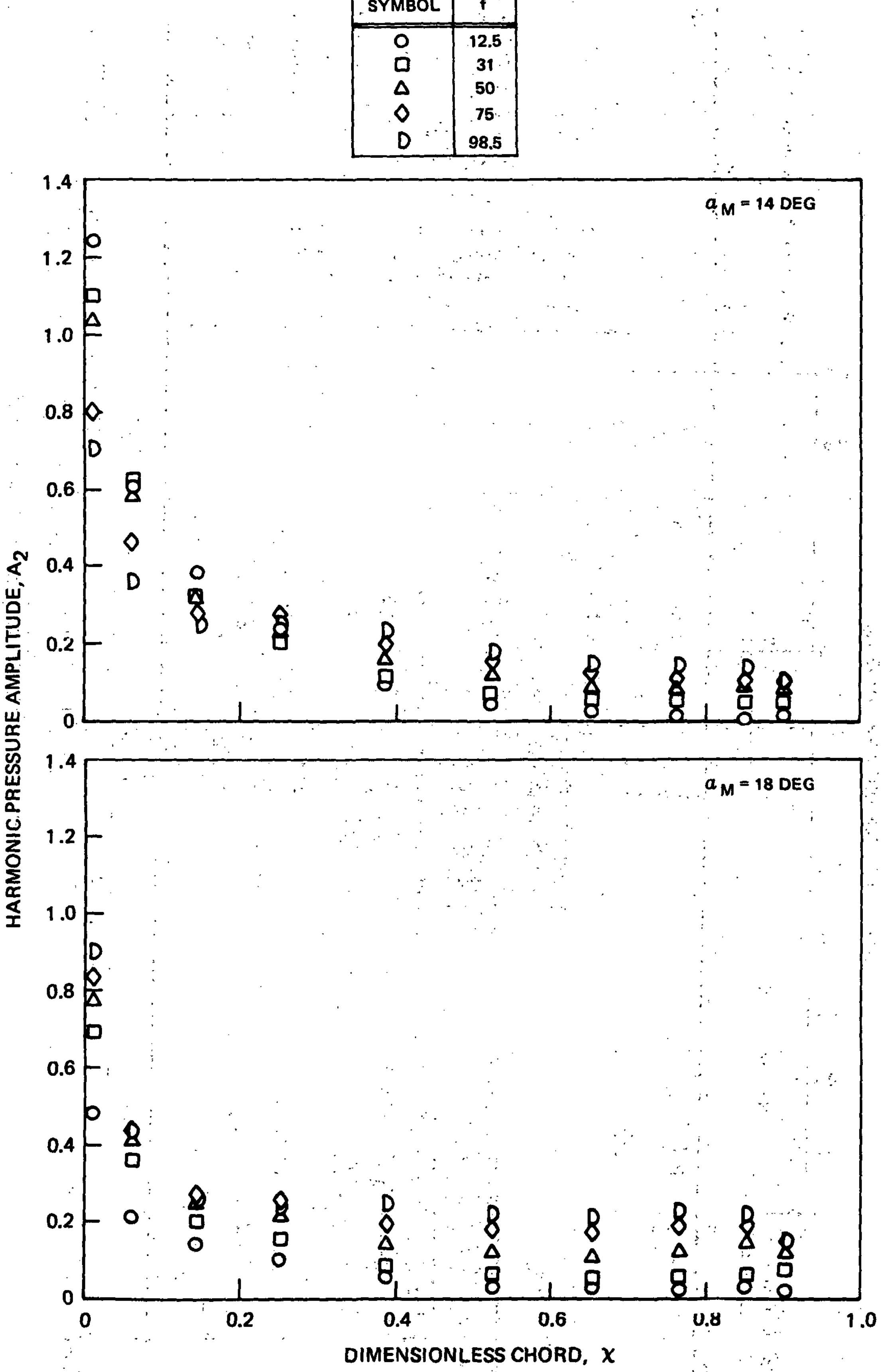


FIGURE 22. CONCLUDED

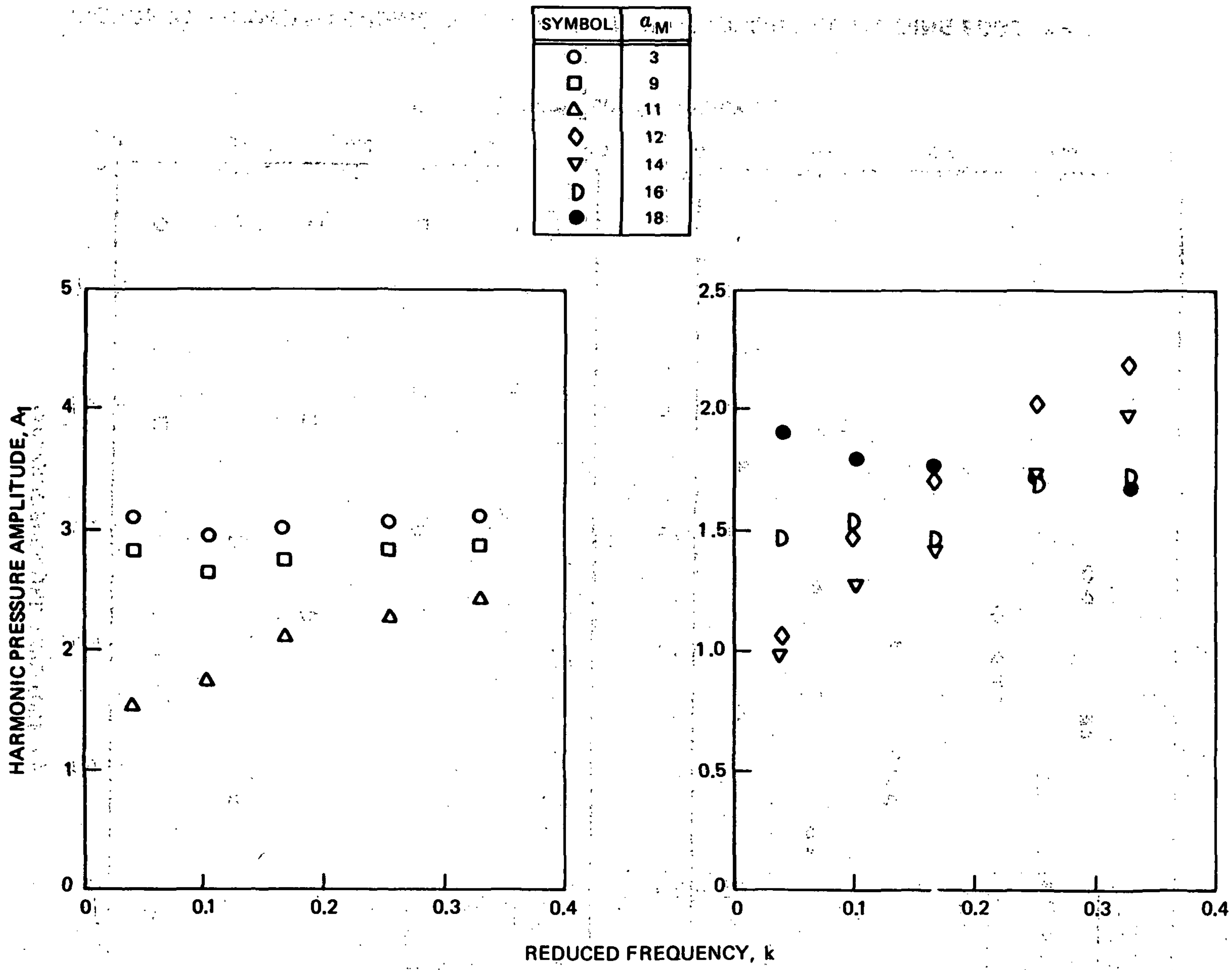


FIGURE 23. FIRST HARMONIC PRESSURE AMPLITUDE AT AIRFOIL LEADING EDGE, $X = 0.0119$

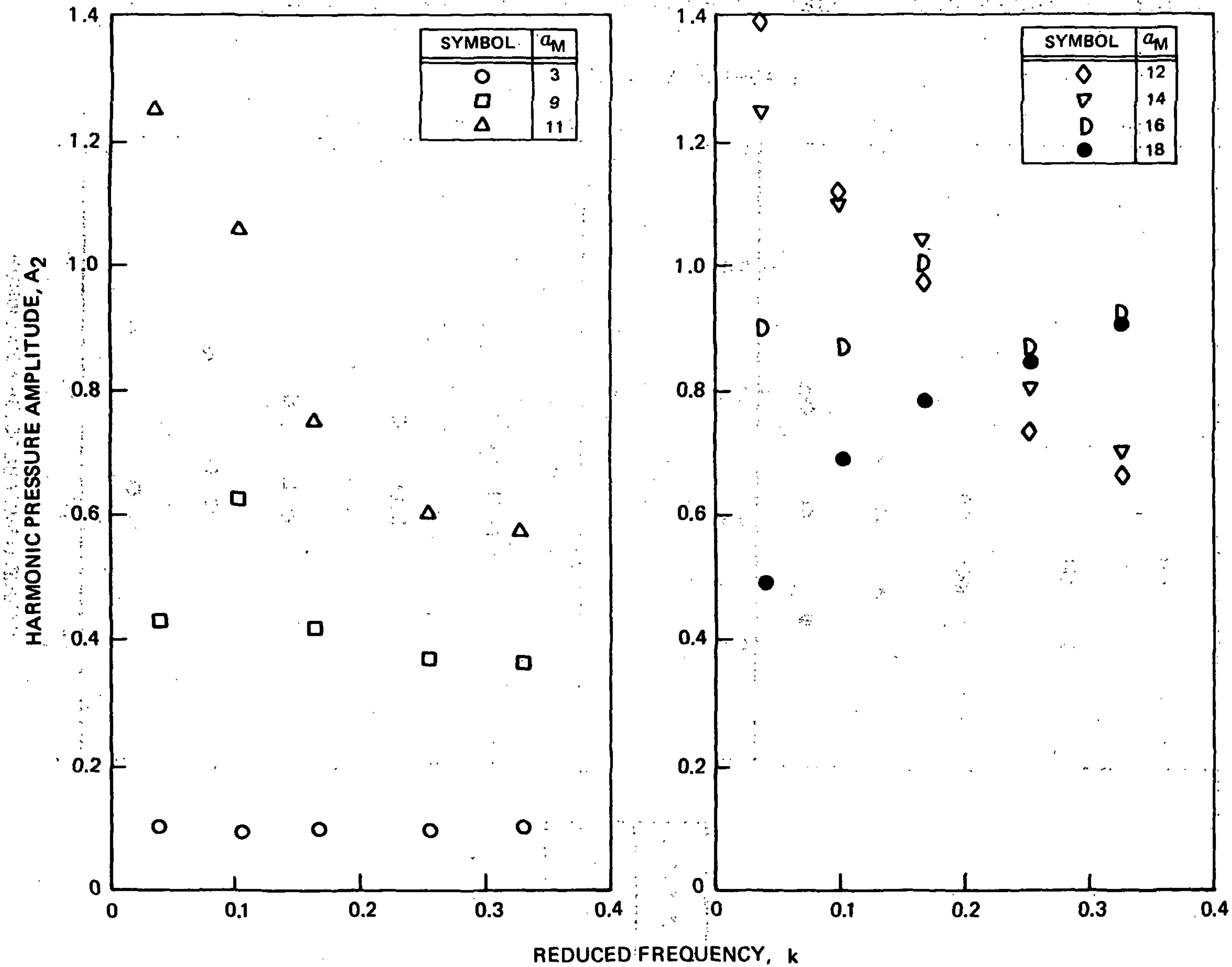


FIGURE 24. SECOND HARMONIC PRESSURE AMPLITUDE AT AIRFOIL LEADING EDGE, $\chi = 0.0119$

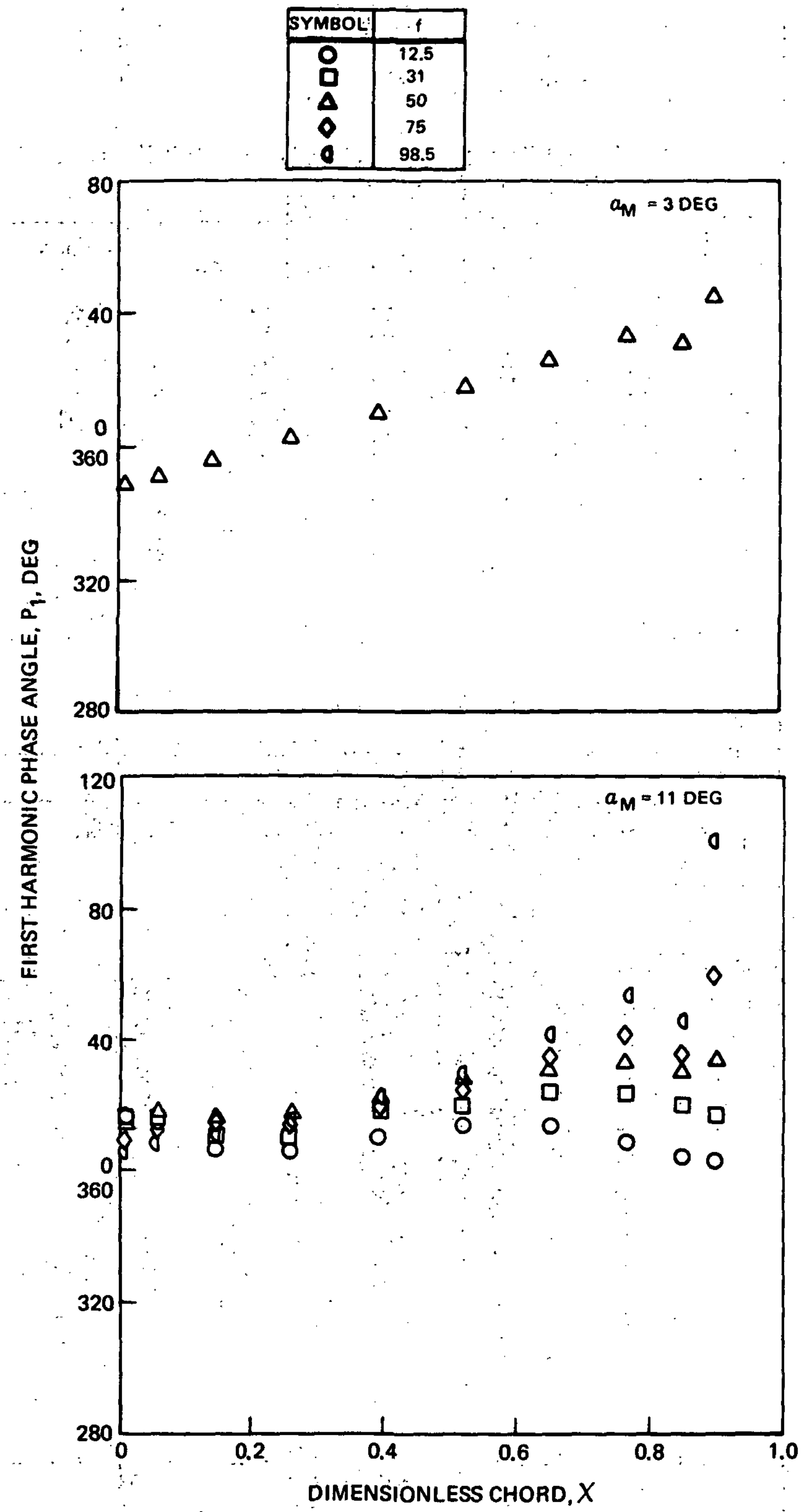


FIGURE 25. CHORDWISE DISTRIBUTION OF FIRST HARMONIC PHASE ANGLE

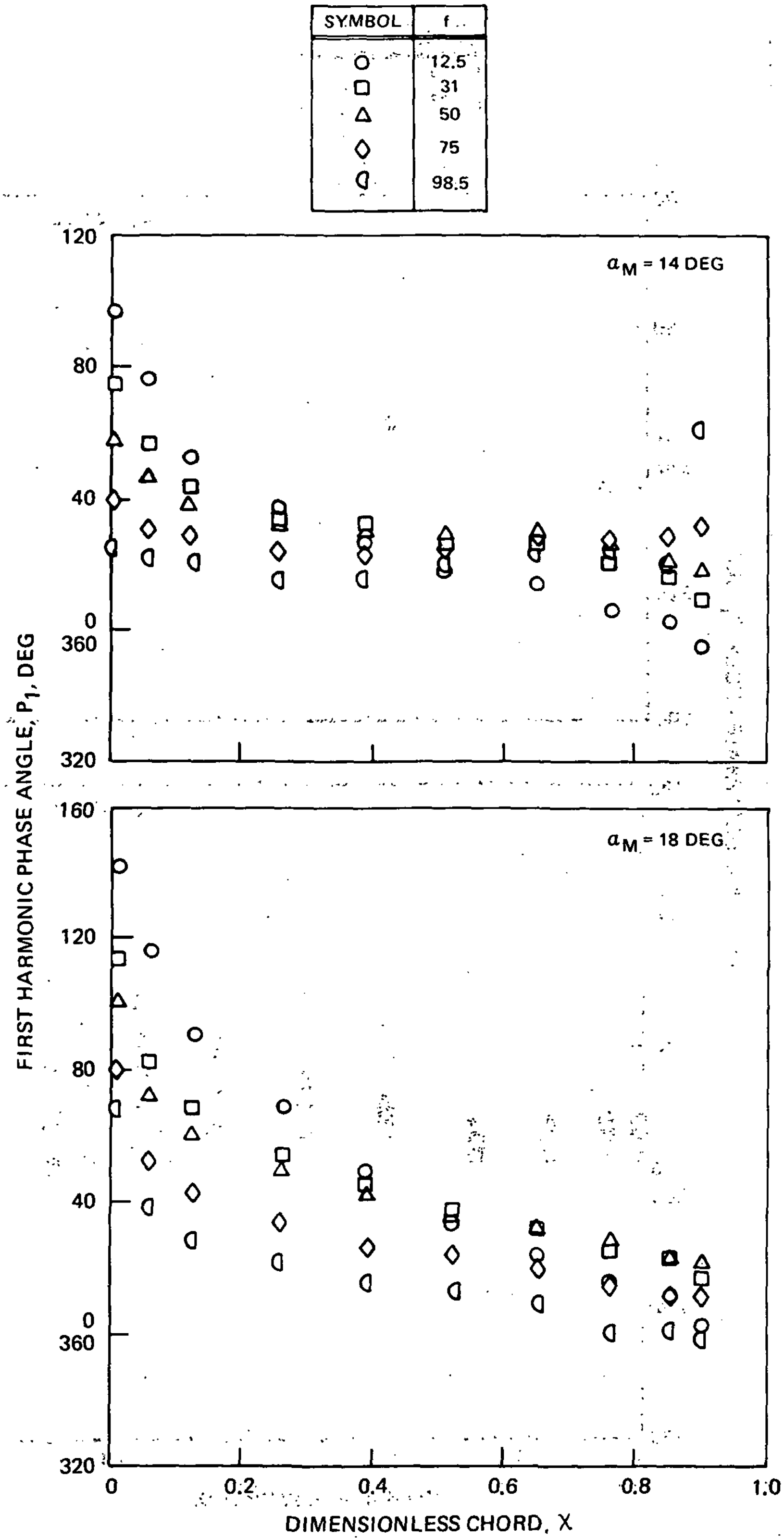


FIGURE 25. CONCLUDED

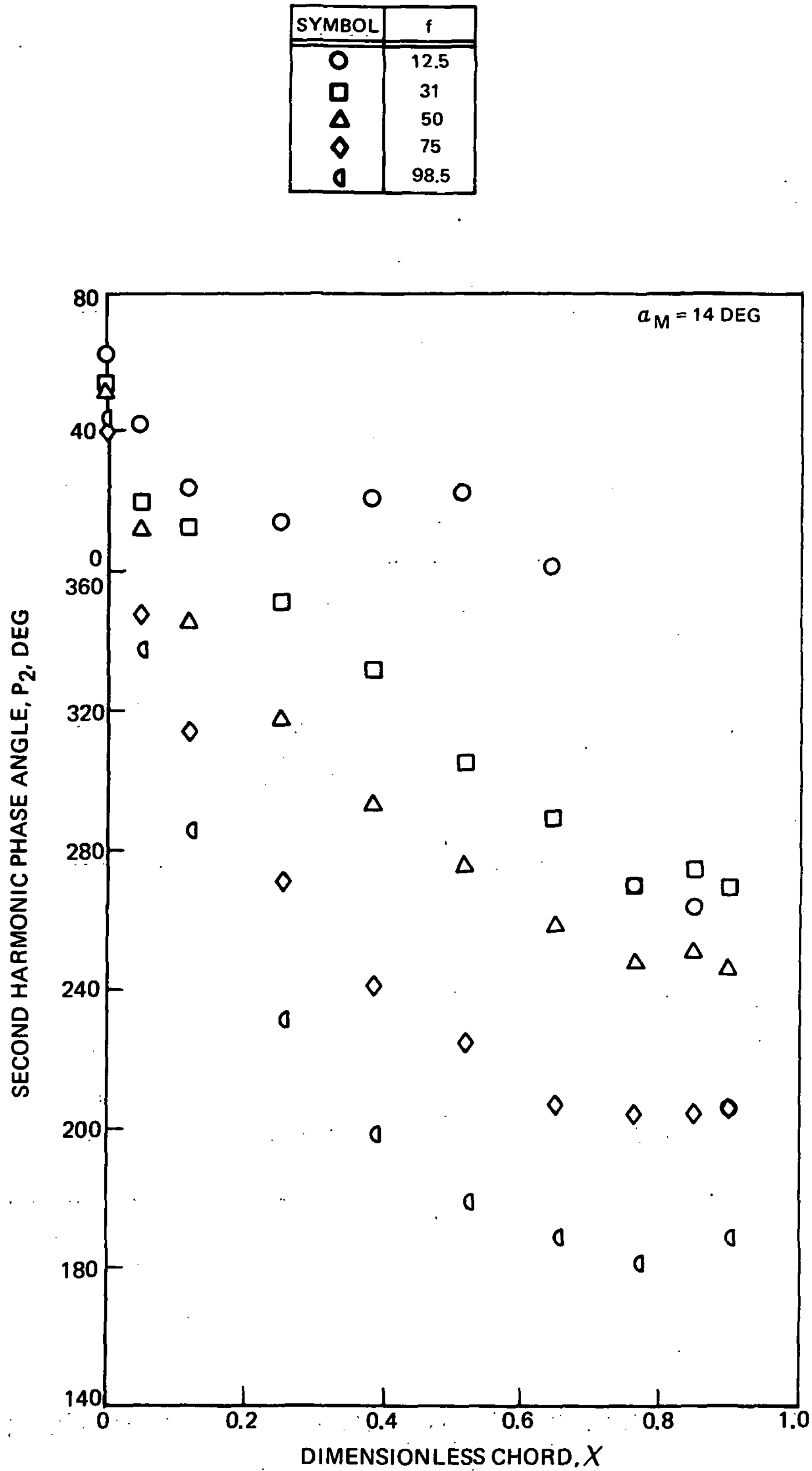


FIGURE 26. CHORDWISE DISTRIBUTION OF SECOND HARMONIC PHASE ANGLE

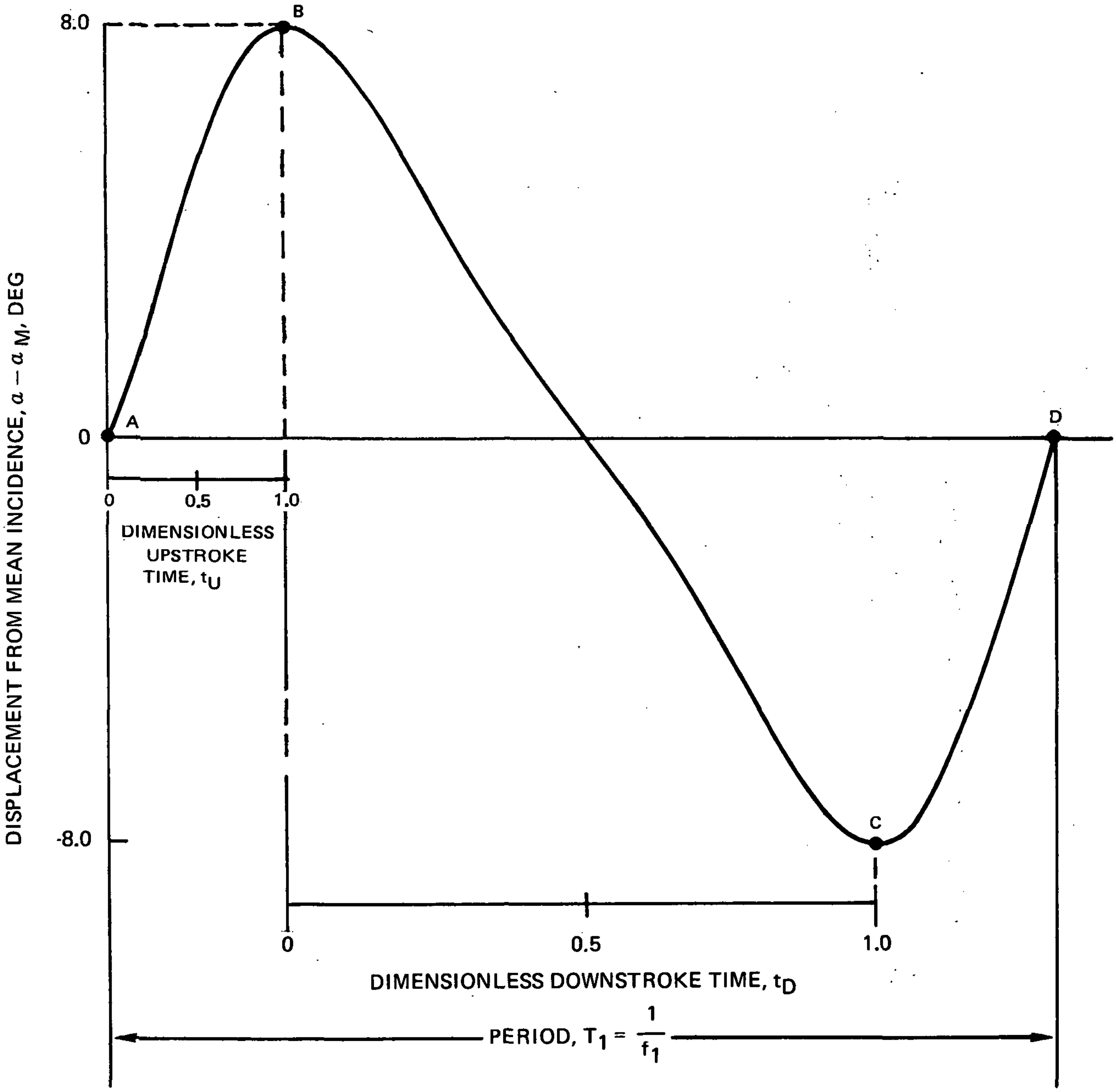


FIGURE 27. ANGULAR DISPLACEMENT TIME HISTORY FOR FORWARD RAMP MOTION

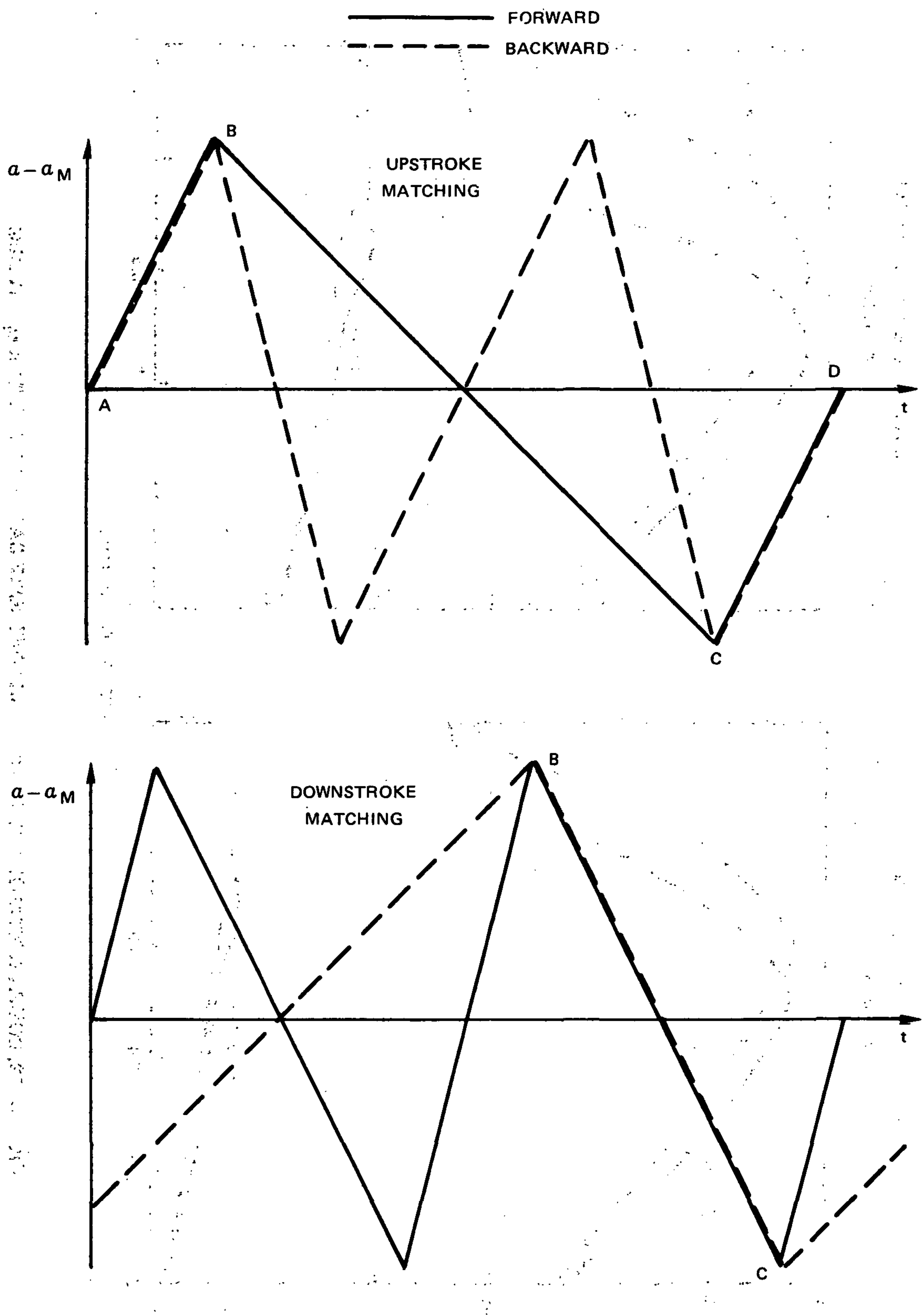


FIGURE 28. RAMP MOTION SCHEMATIC SHOWING UPSTROKE AND DOWNSTROKE MATCHING REGIONS

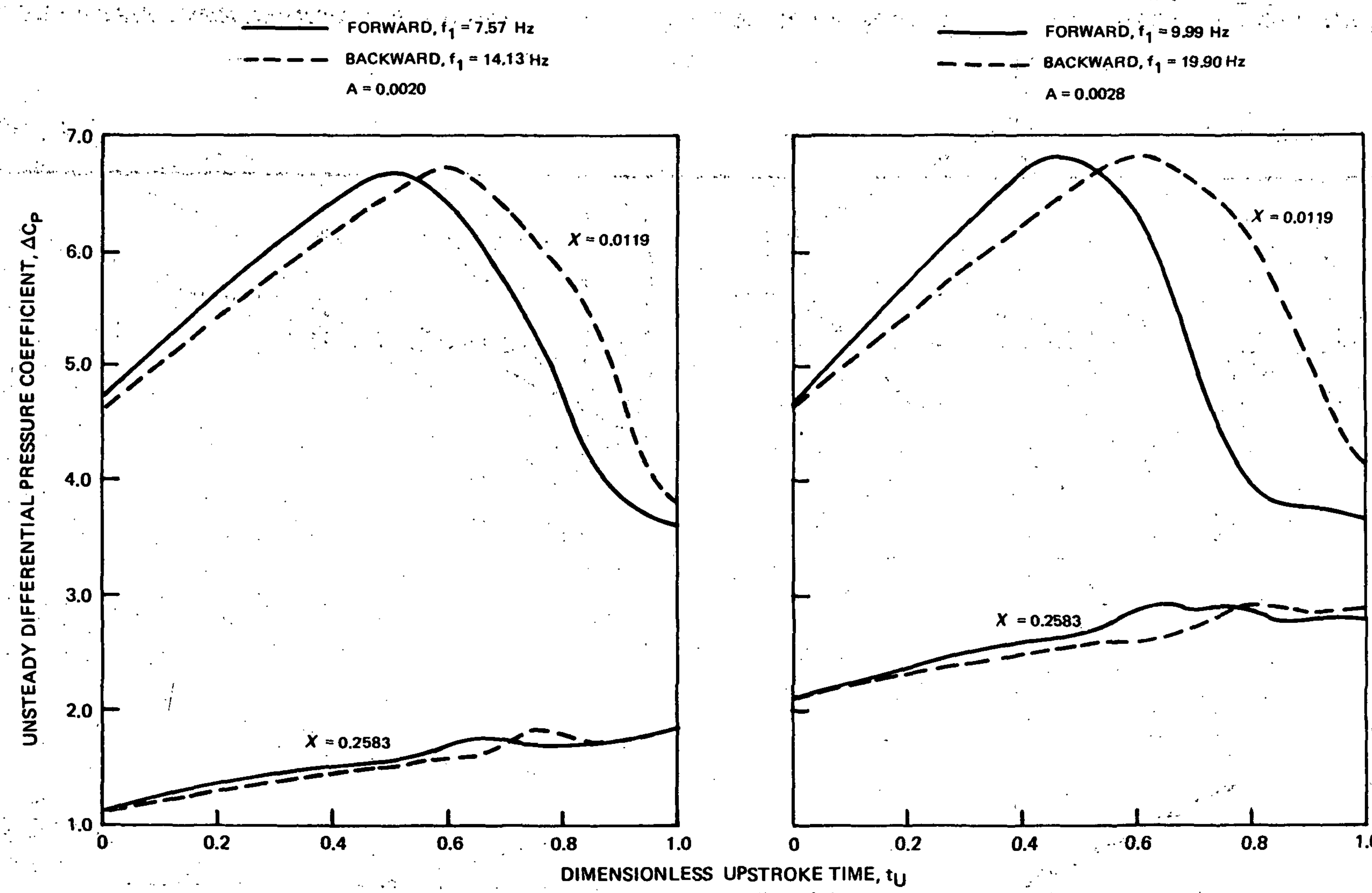


FIGURE 29. COMPARISONS OF PRESSURES FOR UPSTROKE CAM MOTIONS AT α_M = 11 DEG

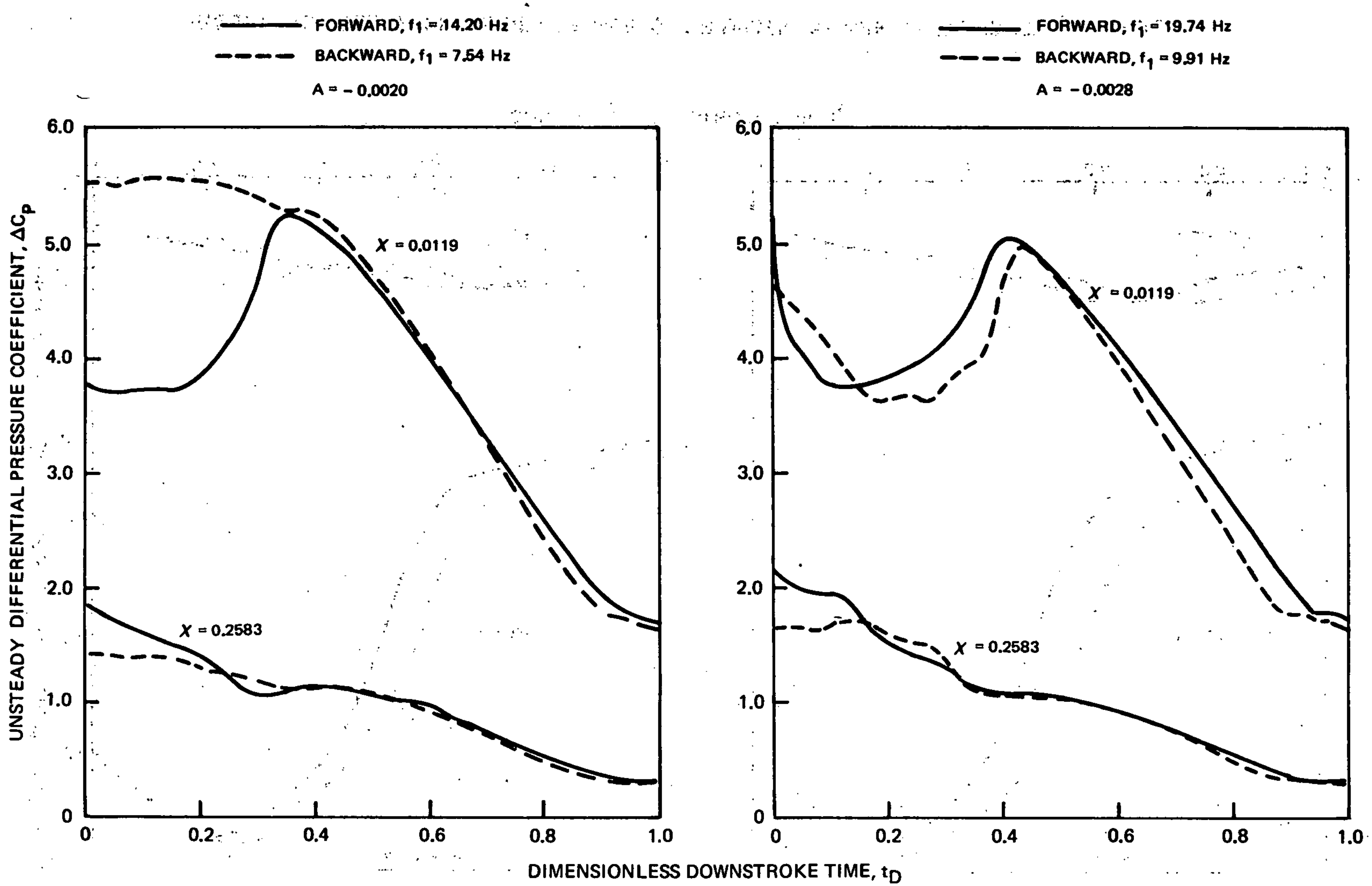


FIGURE 30. COMPARISON OF PRESSURES FOR DOWNSTREAM CAM MOTIONS AT α_M = 11 DEG

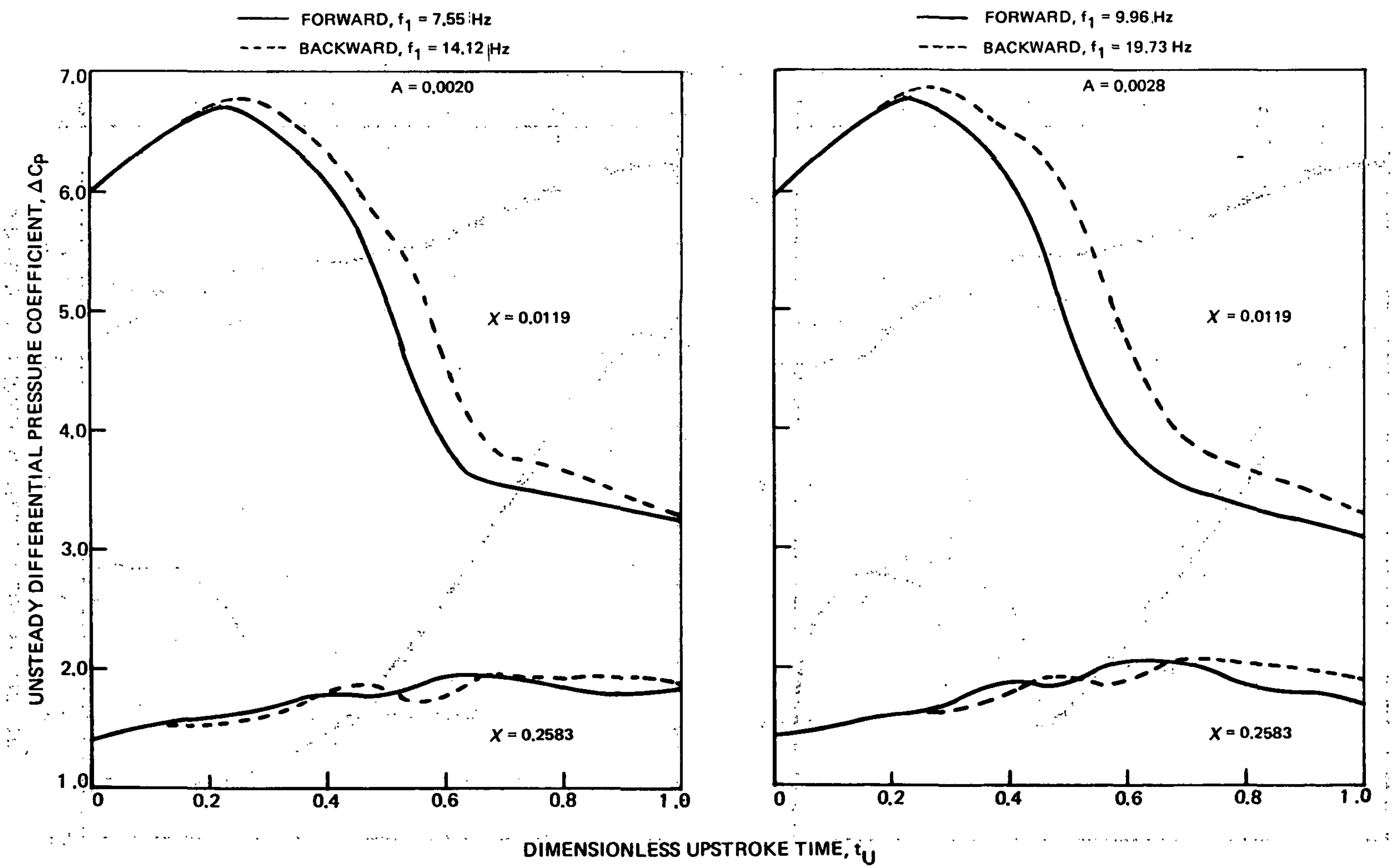


FIGURE 31. COMPARISONS OF PRESSURES FOR UPSTROKE CAM MOTIONS AT α_M = 14 DEG

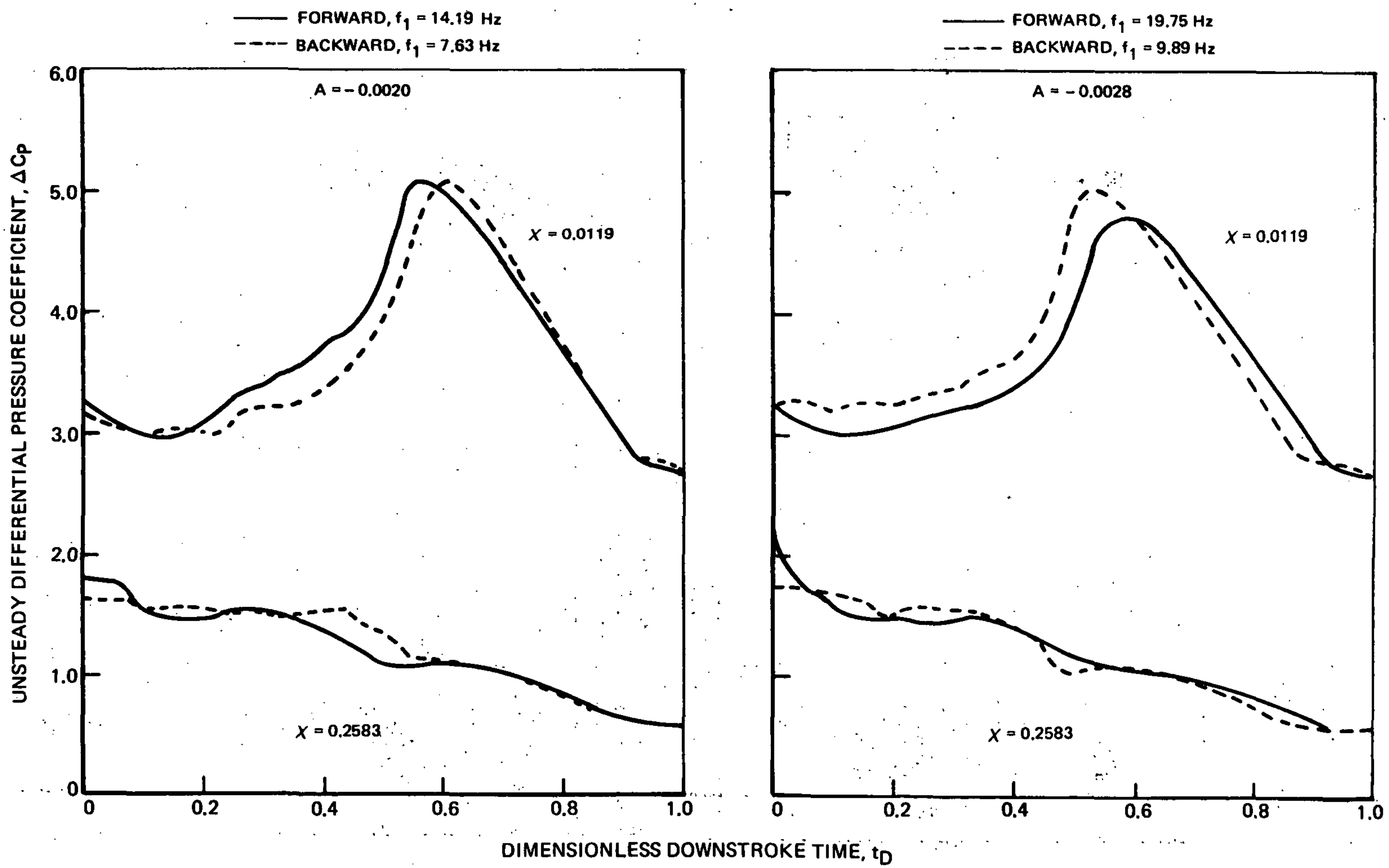


FIGURE 32. COMPARISONS OF PRESSURES FOR DOWNSTROKE CAM MOTIONS AT α_M = 14 DEG

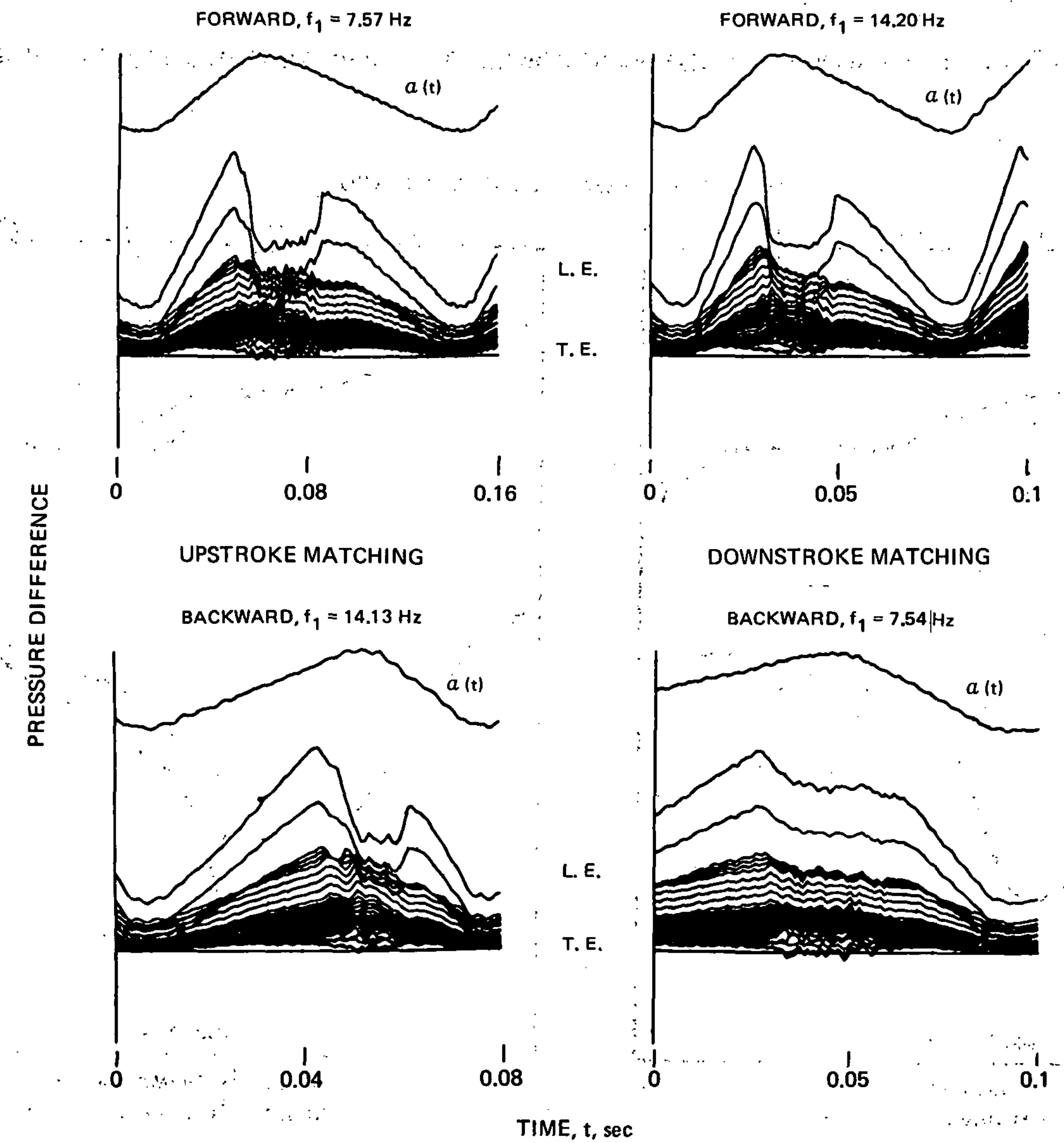


FIGURE 33. COMPARATIVE PRESSURE TIME HISTORIES FOR FORWARD AND BACKWARD RAMP MOTION FOR α_M = 11 DEG

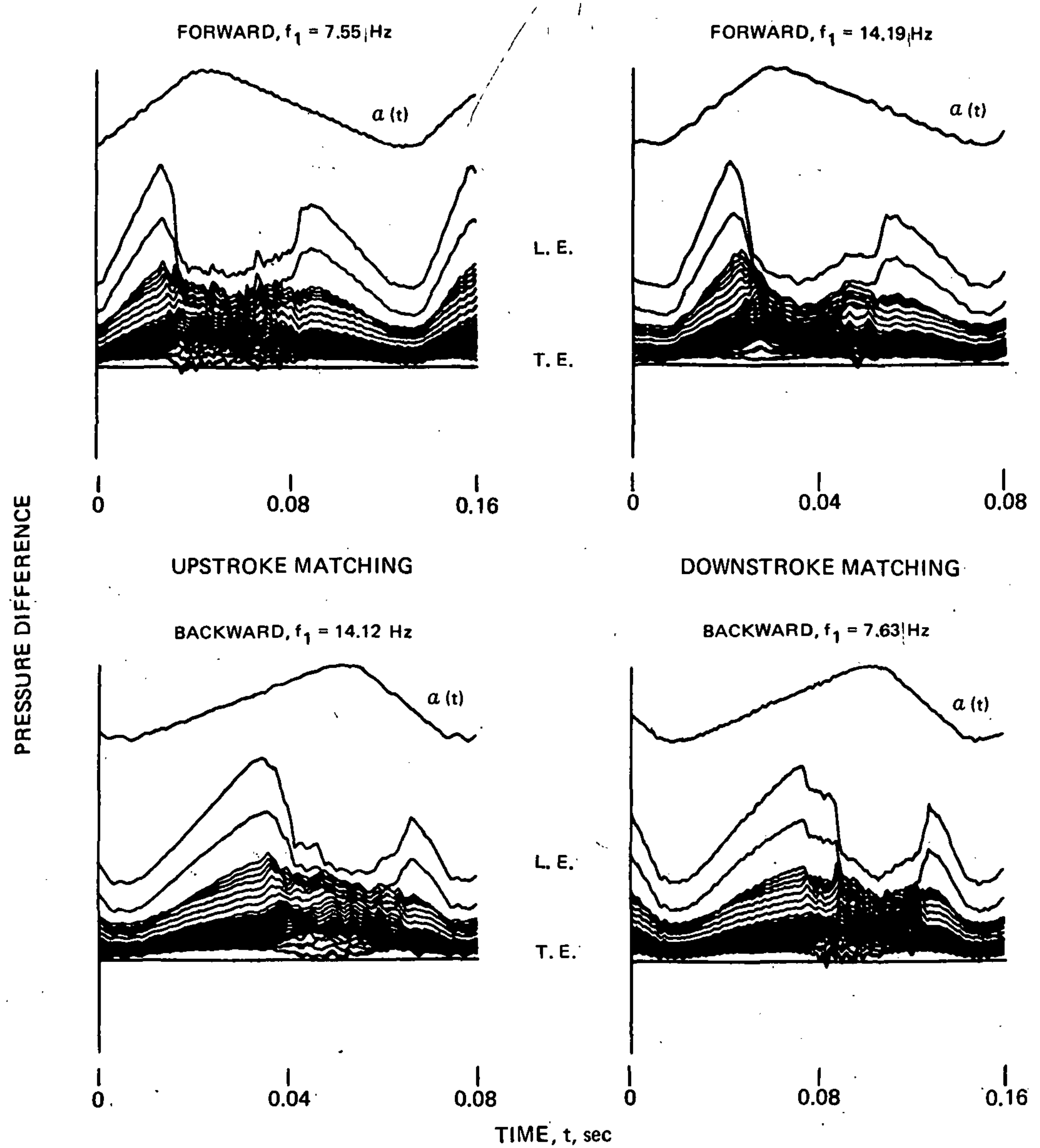


FIGURE 34. COMPARATIVE PRESSURE TIME HISTORIES FOR FORWARD AND BACKWARD RAMP MOTION FOR α_M = 14 DEG

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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