**HIRENASD Experimental Pressure Coefficient Data**

Documentation of Variable definitions, etc contained in the data files

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There are 7 chord-wise rows of pressure transducers. The data sets contain either the static pressure coefficients or the magnitude and phase of frequency response functions (pressure coefficient due to displacement) obtained at the frequency of excitation.

**File names:**

Ascii format: the tecplot data files are ascii files. The variables are specified at the top of the file. For each named zone (one zone per span station, upper surface; one zone per span station, lower surface), the first variable’s values are given in a block, followed by the second variable’s values, etc.

Tecplot format:

*Data files:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Data point | Mach | Reynolds number | Static pressure data file name | Forced oscillation frequency response function file name |
| 155 | 0.7 | 7M | MeanCps\_avgDynData\_T155 | DynData\_P155 |
| 159 | 0.8 | 7M | MeanCps\_avgDynData\_T159 | DynData\_P159 |
| 271 | 0.8 | 23.5M | MeanCps\_avgDynData\_T271 | DynData\_P271 |
| 129 | 0.7 | 7M | MeanCps\_PolarData\_T129\* |  |

\* This data was produced from angle of attack polar data. It is provided here for those who wish to examine the differences in the static data produced by taking the average of polar data at +/- 0.1 degrees relative to the nominal angle of attack. The other polar data points, 132 and 250, were examined by the experimental data reduction team and can be made available if desired.

*Layout files:*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Pt | M | Re (M) | Static pressure layout file | Magnitude of frequency response function layout file | Phase of frequency response function layout file |
| 155 | 0.7 | 7 | Static\_Cp\_T155\_Oct2011\_v2.lay  | Magnitude\_T155\_Oct2011.lay | Phase\_T155\_Oct2011.lay |
| 159 | 0.8 | 7 | Static\_Cp\_T159\_Oct2011\_v2.lay | Magnitude\_T159\_Oct2011.lay | Phase\_T159\_Oct2011.lay |
| 271 | 0.8 | 23.5 | Static\_Cp\_T271\_Oct2011\_v2.lay | Magnitude\_T271\_Oct2011.lay | Phase\_T271\_Oct2011.lay |
| 129 | 0.7 | 7 | Static\_Cp\_T129\_Oct2011\_v2.lay Static\_Cp\_T155\_and\_T129\_Oct2011\_v2.lay \* |  |  |

Matlab files:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Data point | Mach | Reynolds number | Static pressure data file name | Forced oscillation frequency response function file name |
| 155 | 0.7 | 7M | MeanCps\_avgDynData\_T155\_mat | DynData\_P155\_mat |
| 159 | 0.8 | 7M | MeanCps\_avgDynData\_T159\_mat | DynData\_P159\_mat |
| 271 | 0.8 | 23.5M | MeanCps\_avgDynData\_T271\_mat | DynData\_P271\_mat |
| 129 | 0.7 | 7M | MeanCps\_PolarData\_T129\* |  |

**Excitation Frequencies for each data point:**

|  |  |
| --- | --- |
| Data Point | Excitation Frequency, Hz |
| 155 | **78.9** |
| 150 | **78.9** |
| 271 | **80.3** |

**Variable names: (for matlab-specific information, please see additional description at the end of this document)**

|  |  |  |
| --- | --- | --- |
| Variable name | Definition | Units, where appropriate |
| x | Flow-direction coordinate, positive aft | meters |
| y | Span-wise coordinate, positive root to tip | Meters |
| z | Wing thickness direction coordinate, positive from wing bottom surface to wing top surface; (right hand rule using x and y definitions) | meters |
| section (or station or span\_station) | Numbering of the chord-wise rows of pressure transducers: the station closest to the root is labeled 1; the station closest to the tip is labeled 7 |  |
| Port number ( or isensor\_keep) | Pressure port number for a given span station. The pressure transducer numbering is separate for each span station. Top and bottom ports are numbered as a single set. Missing numbers in the sequence indicate sensors that were determined to be nonfunctional (Data point 132 was used to make this functionality assessment.)  |  |
| MeanCp | Static pressure coefficient (static cases only) |  |
| Magnitude | Magnitude of the frequency response functions (dynamic cases only) |  |
| Phase | Phase of the frequency response functions (dynamic cases only) | degs |
| x\_normalized | At each span station, the x-coordinate is normalized to run from 0 to 1. Using the leading edge coordinate and chord for each span station, the normalized coordinate is computed: X\_normalized =(X – X\_le)/chord |  |

**Static Pressure Coefficient calculation**

The static pressure coefficients were computed from the forced oscillation time history data points of the experimental data sets. In each forced oscillation time history, there are 3 time segments where there is nominally no excitation. (Close scrutiny of these time segments show that there is a very low level excitation signal still present on the command.) The mean values of the pressure coefficients, averaged over these low-level excitation segments are used as the static pressure coefficients.

**Frequency Response Functions**

The frequency response functions were computed as the pressure coefficient due to displacement at station (15,1). Station (15,1) is defined as the location of accelerometer (15,1), (x=1.24521, y=0.873034). The input quantity, displacement, was generated by integration of the measurement from accelerometer\_15\_1. The displacement produced was then normalized by the reference chord, 0.3445 meters. The pressure data was delivered as non-dimensional pressure coefficients.

The frequency response functions were produced using only the first, lower amplitude, excitation segment of the time history data in all cases currently on the AePW website.

The frequency response functions were produced using Fourier analysis methods.

The ratios of cross-spectral density (CSD) functions and power-spectral density (PSD) functions generated frequency response functions over a range of frequencies. Data is then extracted at the single analysis frequency most closely corresponding to the presumed excitation frequency. Note that in the current processing, the frequency is not calculated based on the peak of the PSD, but the frequency specified in the test matrix is used. Each pressure sensor has a single data point associated with it for a given test point. These points are generally complex numbers. The real and imaginary parts of the complex numbers are presented in the graphs and in the data files as the magnitude and phase. Magnitude = sqrt(real^2 + imag^ 2); Phase =180/pi\* tan^(-1)(imag/real).

 using Fourier analysis methods of the pressure coefficient data and integrating the accelerometer data at station (15,1).

**Coordinate system definition**:

Origin is located at the wing root leading edge. Positive directions: x- flow-wise: aft; y- spanwise: from root to tip; z- wing thickness direction: from wing lower surface to upper surface (right hand rule using the defined x and y positive directions)\_

Note that I am using these awkward descriptions because the model was tested vertically suspended from the wind tunnel ceiling. The lift is still in the z-axis direction, but the usual definitions of up and down, relative to gravity are not in the z-axis direction.

**Reference Quantities:**

Span = 1.285 meters

Reference chord length = 0.3445 meters (note that this is not used in normalizing the chord sections. The local chord length is used)

Reference signal for FRF: displacement at accelerometer location 15,1: x=1.24521, y=0.873034

For additional details on normalization etc, please consult the Geometry definitions files and documentation.

**Span station information (files containing this information can be found in Geometry files):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Station** | **Y coordinate, meters** | **Eta** | **x\_le, meters** | **Local chord, meters** |
| 1 | 0.1848 | 0.145 | 0.1247 | 0.4431 |
| 2 | 0.4135 | 0.323 | 0.2790 | 0.3507 |
| 3 | 0.5846 | 0.456 | 0.3945 | 0.3024 |
| 4 | 0.7559 | 0.589 | 0.5100 | 0.2540 |
| 5 | 0.8408 | 0.655 | 0.5673 | 0.2336 |
| 6 | 1.0325 | 0.804 | 0.6965 | 0.1962 |
| 7 | 1.224 | 0.953 | 0.8258 | 0.1589 |

**MATLAB structures**

The variables defined above are in the matlab data file, but they are incorporated into data structures.

The static pressure files contains 3 data structures: station\_geom and Xducer\_locs\_output and Mean\_cp.

The forced oscillation pressure files contain 3 data structures: station\_geom and Xducer\_locs\_output and Tdlr\_savedata\_1x.

**station\_geom** has 5 fields x\_le, x\_te, chord, y and eta. Each of these fields contains 7 values, one for each span station.

Example of extracting data from this data structure:

The nondimensional y location of the 5th station:

Eta\_spanstation5 = station\_geom.eta(5)

**Xducer\_locs\_output** has 8 fields of data: n\_sensors, x,y,z,nsens,x\_normalized, x\_signed and isensor\_keep

Example of extracting data from this data structure:

The nondimensional x location of the 10th transducer at the 5th span station:

x\_normalized\_5\_10 = Xducer\_locs\_output(5).x\_normalized(10)

**STATIC DATA: Mean\_cp** has 1 field, tf\_excit.

Example of extracting data from this data structure:

The mean pressure coefficient of the 10th transducer at the 5th span station:

Mean\_cp\_5\_10=Mean\_cp(5).tf\_excit(10)

**FORCED OSCILLATION DATA:** **Tdlr\_savedata\_1x**  has 1 field, tf\_excit

This data is the complex number that defines the frequency response function. From this data, the magnitude and phase are computed by the following commands in matlab:

 jjj is the section number; indices\_surf is a vector of the port numbers at that section to extract

Mag\_surf=abs(Tdlr\_savedata\_1x(jjj).tf\_excit(indices\_surf)); Phase\_surf=180/pi\*angle(Tdlr\_savedata\_1x(jjj).tf\_excit(indices\_surf));