INITIAL TEST RESULTS ON STATE ESTIMATION ON THE SCOLE MAST

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Abstract

Modal state estimation tests are performed on the SCOLE mast for the fixed Shuttle platform case. Kalman filter state estimation results from a five mode computer model of the SCOLE mast, developed from a finite element analysis, are compared with those state estimates obtained from laboratory tests. Two comparison runs are presented, one an excitation of the first two bending modes, another, an excitation of the first torsional mode of the mast. Results from both runs show poor agreement in modal estimation between the computer model simulations and the laboratory test data. At present, the reason(s) for this poor performance is unknown. Both the laboratory hardware and software and the computer model are being checked for possible sources of errors. Further computer simulations as well as laboratory testing will be performed.

MODEL OF SCOLE MAST

- ⊙ MODAL DATA FORM FINITE ELEMENT ANALYSIS OF MAST
- ⊙ FIVE DECOUPLED MODES (FREQUENCIES .443-4.345 HZ)
- ⊙ ACTUATORS: FOUR JETS AND THREE REACTION WHEELS
- ⊙ SENSORS: SIX LINEAR ACCELEROMETERS AND 3 AXIS RATE GYRO
- ⊙ MODAL STATE AND OUTPUT EQUATIONS:

$$X(k+1) = AX(k) + BU(k)$$

$$Y(k) = CX(k) + DU(k)$$

- ⊙ STATES ESTIMATED BY KALMAN FILTER

KALMAN FILTER

⊙ EQUATIONS IN BASIC FORM:

$$\tilde{X}(k+1) = A\hat{X}(k) + BU(k)$$

$$\hat{X}(k+1) = \tilde{X}(k+1) + G(Y(k) - \hat{Y}(k))$$

$\tilde{X}$ - PREDICTED STATE

$\hat{X}$ - ESTIMATED STATE

G - KALMAN FILTER GAIN MATRIX

⊙ KALMAN FILTER GAINS ASSUMED CONSTANT

- SENSOR NOISE INTENSITIES ESTIMATED FROM MANUFACTURERS' DATA

⊙ ABOVE FORM USED IN SOFTWARE FOR LABORATORY TESTS

SIMULATION AND TEST PARAMTERES

RUNS USED FORCING FUNCTION TO EXCIT SCOLE MAST

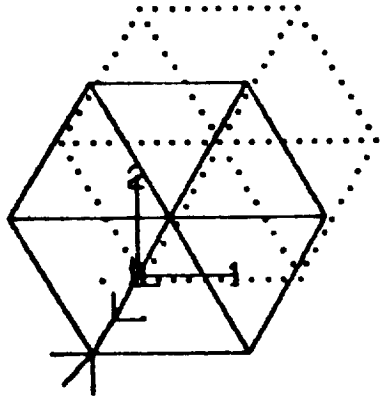
$$F = A \sin(\omega T)$$

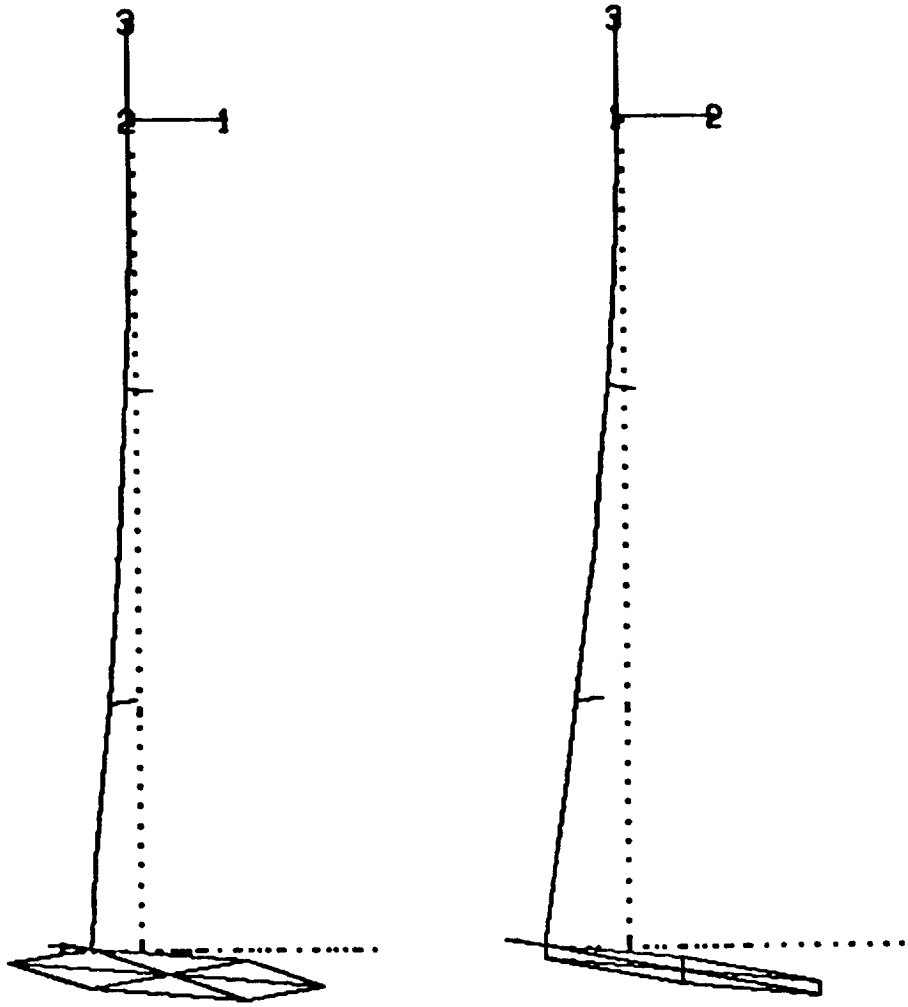
RUN	EXCITATION TIME	FREQUENCY	AMPLITUDE	DURATION
1	10 sec	.443 HZ	5.0	30 sec
2	10 sec	1.504 HZ	2.0	30 sec

⊙ COMPUTER SIMULATIONS USED SAME VALUES

EAL 1ST BENDING MODE (MODE 1)

VIBRATIONAL MODE. FREQ (HZ) .4426 X10 +00

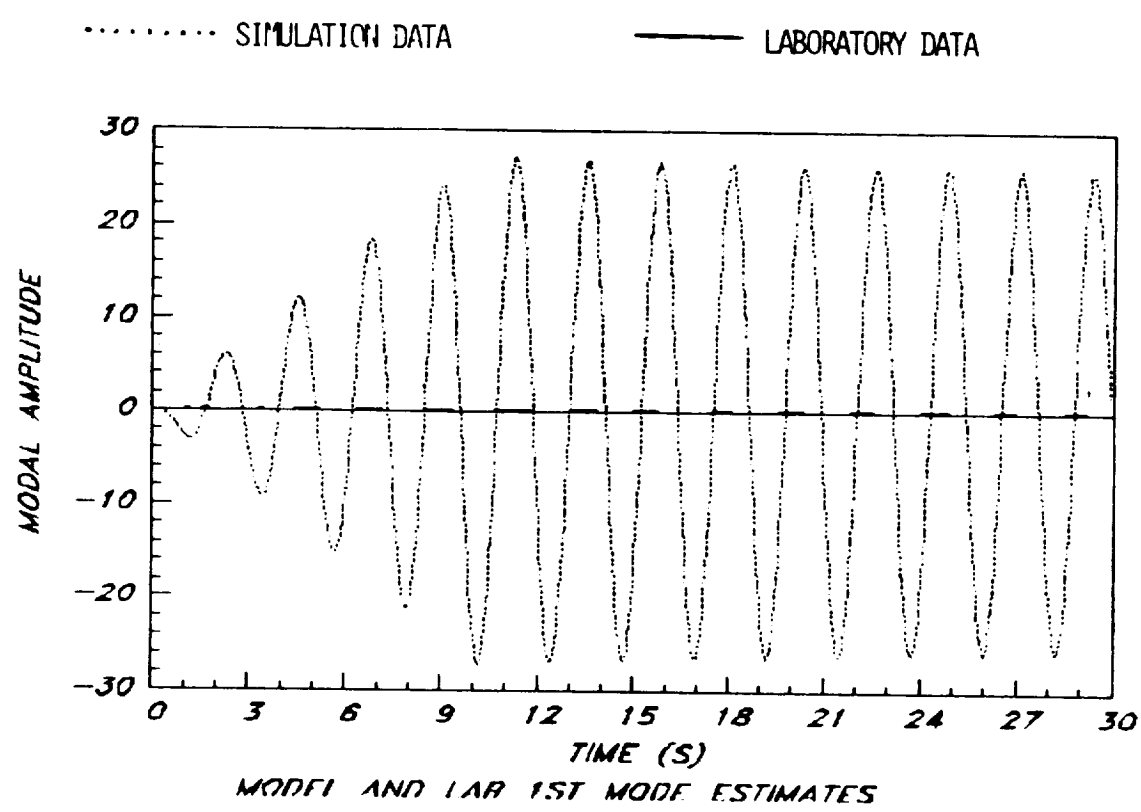




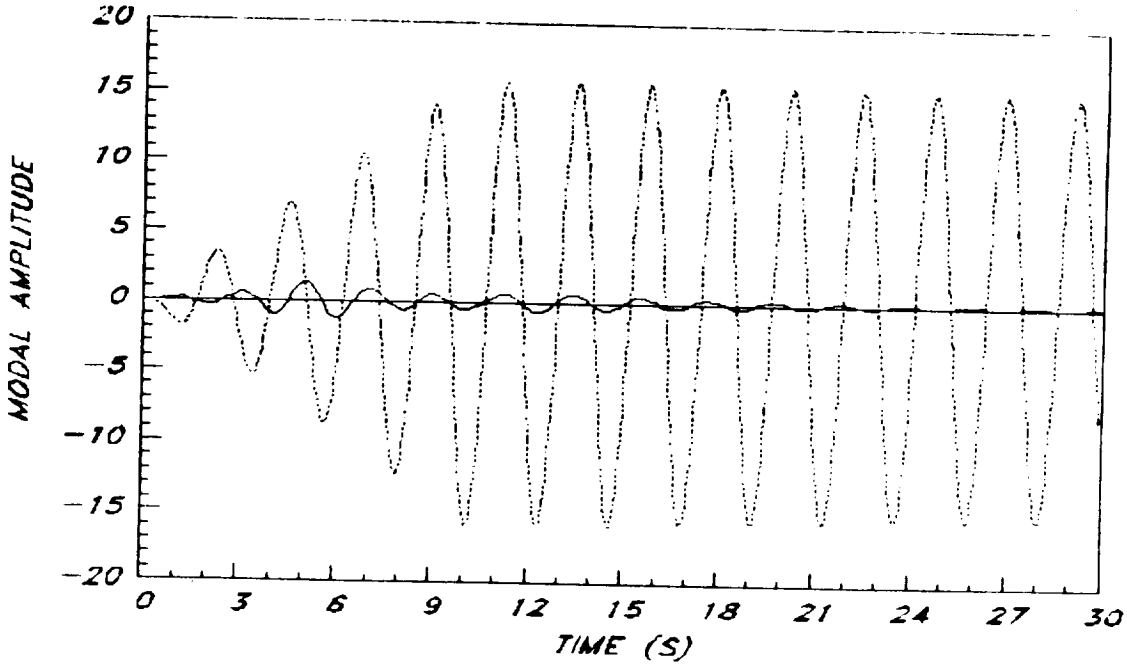
SPEC
1.1

SCOLE VIBRATIONAL MODE SHAPE 1

RUN #1 X - WHEEL INPUT



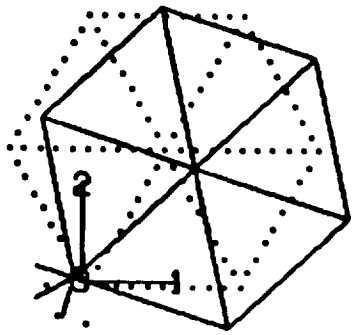
MODEL AND LAB 1ST MODE ESTIMATES

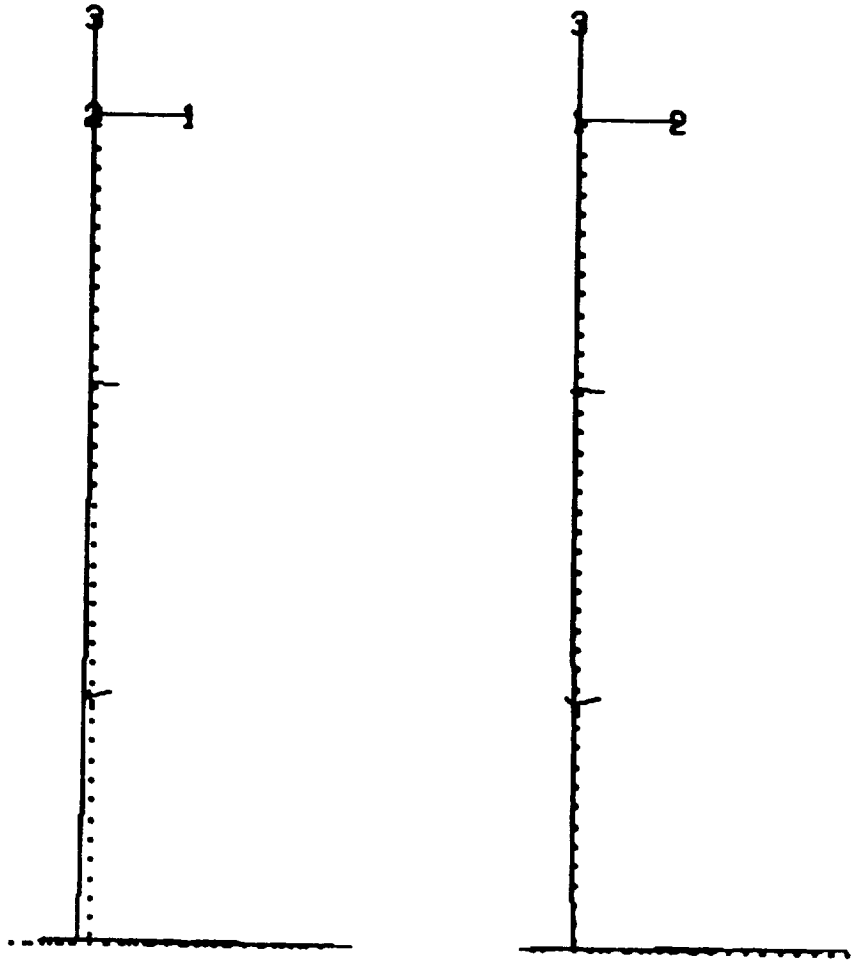


MODEL AND LAB 2ND MODE ESTIMATES

EAL 1ST TORSIONAL MODE (MODE 3)

VIBRATIONAL MODE. FREQ (HZ) . 1504 X10 +01

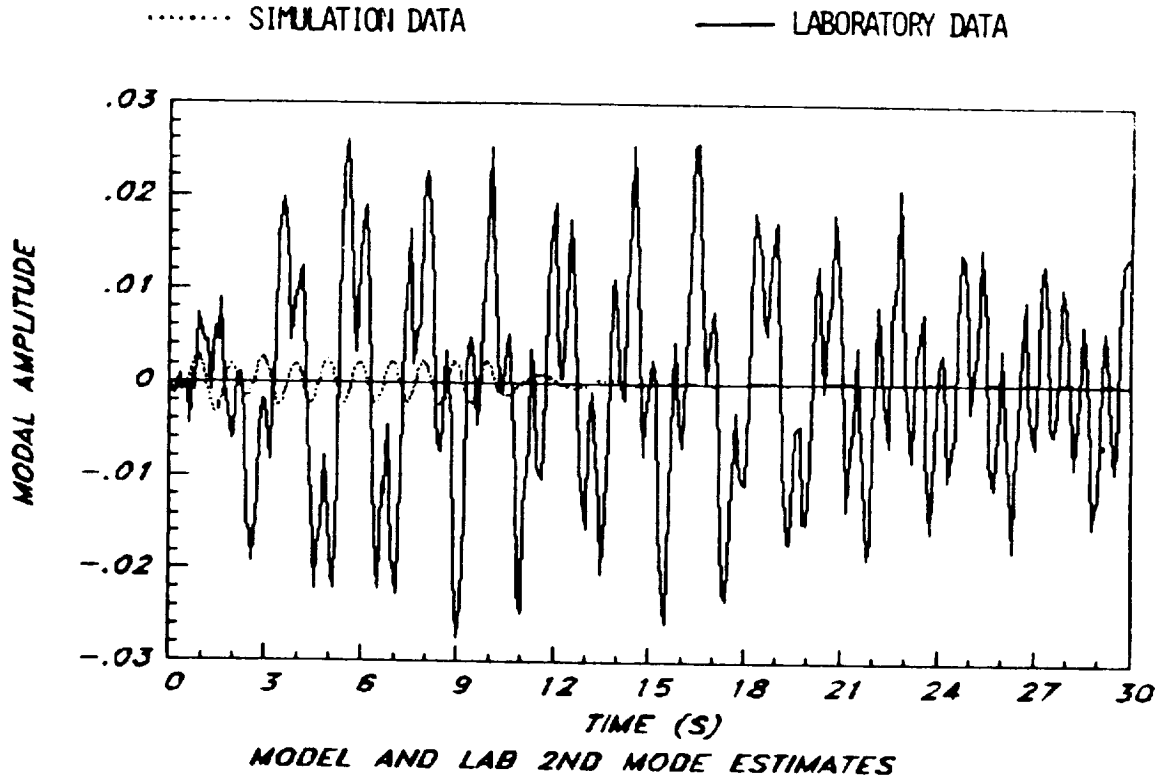




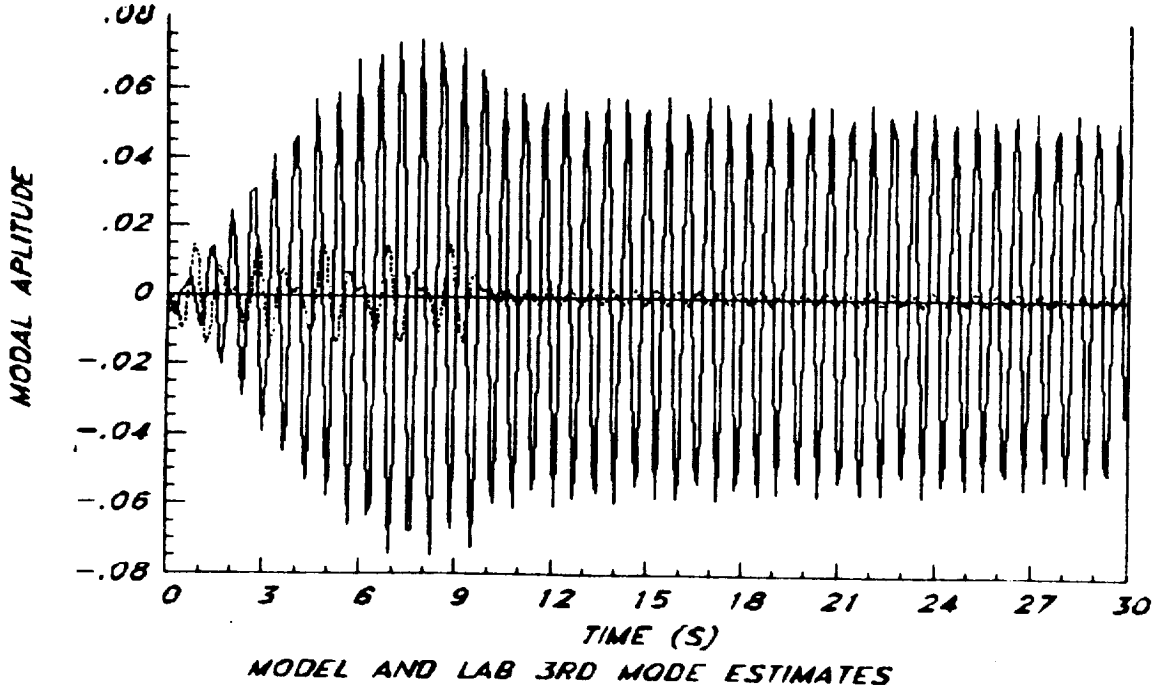
SPEC
3 1

SCOLE VIBRATIONAL MODE SHAPE 3

RUN # 2 z - WHEEL INPUT



MODEL AND LAB 2ND MODE ESTIMATES



MODEL AND LAB 3RD MODE ESTIMATES

COMMENTS

- ⊙ LABORATORY AND COMPUTER SIMULATIONS OF MODE ESTIMATES ARE VERY DIFFERENT !

- ⊙ ONLY GENERAL AGREEMENT BETWEEN LABORATORY AND COMPUTER SIMULATION IS IN WHICH MODES ARE "DOMINANT" FOR THE RESPECTIVE FORCING FUNCTIONS

- ⊙ CONFIDENCE IN LINEAR COMPUTER SIMULATION MODEL

SUMMARY

- ⊙ MORE LABORATORY TESTS ARE REQUIRED

- ⊙ RE-CHECK LABORATORY APPARATUS (SOFTWARE AND HARDWARE)

- ⊙ PARAMETER IDENTIFICATION AND RE-DEFINING MODEL OF SCOLE SIMPLE LINEAR DECOUPLED MODAL MODEL MAY NOT BE SUFFICIENT FOR PROPER LABORATORY EXPERIMENTS