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ADP010704 thru ADP010735

11E. RAE TESTS ON AGARD TAILPLANE

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INTRODUCTION

This data set relates to tests at RAE which were carried out and reported by D G Mabey, B L Welsh and B E Cripps, ref.1. The tests were undertaken to provide data for the validation of codes for the prediction of both steady and unsteady pressures on low aspect ratio configurations, suitable for the wings or controls of military aircraft. Comprehensive measurements have not been available to verify such codes, although some measurements were obtained during the NORA programme. This was a collaborative test on a low aspect ratio model oscillating about a swept axis, with the main aim of investigating dynamic interference in transonic wind tunnels. NORA was named after the participating organisations: NLR, ONERA, RAE, and AVA (branch of DFVLR). For the verification of transonic theories, a serious limitation of the NORA tests was that the steady and unsteady pressures were measured at different sections, with only a few measurements at each section. To overcome the lack of comprehensive measurements on a low aspect ratio configuration it was decided to make extensive measurements of steady and unsteady pressures on a model of the AGARD SMP (Structures and Materials Panel) tailplane, which has a planform similar to that of the wings and controls used on many military aircraft.

Previous tests have shown that for experiments in time-dependent aerodynamics it is essential to minimise aeroelastic distortion when the model is driven. To avoid measured pressures with a significant contribution due to the distortion in the present tests, the model had to move almost as a rigid body when it was oscillated at high frequencies. Hence the model was constructed in carbon fibre, which provided both high stiffness and low inertia. The high stiffness was aided by the 10% thickness of the section used, which is significantly thicker than the sections usually employed on combat aircraft. These two parameters ensured that the first bending frequency was high for a model of this size, 180 Hz when bolted to a large mass reducing to 120 Hz when the model was mounted on the drive system. This determined the maximum drive frequency to about 70 Hz, up to which frequency the model distortions were small.

This paper considers the measurements made in the RAE 3ft Wind Tunnel at Bedford in December 1982. The same model has been tested over a wider range of conditions in the DFVLR 1m Tunnel at Göttingen in October 1983 under a collaborative programme.

LIST OF SYMBOLS AND DEFINITIONS

c	local chord
C_p	pressure coefficient, $(p- p_\infty) /q$
C_{pm}	mean pressure coefficient, $(p- p_m) /q$
CPMAG	magnitude of oscillatory pressure coefficient C_p
CPPHASE	phase angle of oscillatory pressure coefficient C_p (deg)
CPST	steady pressure coefficients, mean value during oscillation C_{pm}
F	frequency (Hz)
M	free stream Mach number
M_e	local Mach number external to boundary layer
p	pressure
$\bar{p}$	root mean square pressure fluctuation
p_m	mean pressure during oscillation
p_∞	static pressure
q	dynamic pressure
Re	Reynolds number, based on wing semi-span

VMST	local Mach number
α	geometric angle of incidence (deg)
α_m	model angle of incidence corrected for flow angle (deg)
δ	pitch amplitude (deg)
ε	root mean square wing root strain
η	non-dimensional spanwise coordinate (based on model semi-span)
Λ_L, Λ_T	Sweep angle, leading edge and trailing edge, deg
ξ	non-dimensional chordwise coordinate (x/c)

PRESENTATION OF DATA

Sample flow visualisations are presented as data files VIS9A3.JPG, VIS9A5.JPG, VIS11A3.JPG, and VIS131A0.JPG (see 6.11)

The sectional geometry is given as an ASCII file RAEGEOM.DAT for 6 sections. The data are in the format of heading denoting the section station followed by 51 values of chordwise position and height.

The data for all runs are included on a single ASCII data file RAETPSEL.DAT. A FORTRAN program (RAETPR.FOR) is provided which demonstrates the extraction of the data. The program includes a sample main segment which lists the data of a run via a call to subroutine RAESEL. This subroutine may be employed in a user's code to extract the data for a single run or to serve as a model for other data extraction codes.

RAESEL subroutine

A description of the subroutine arguments follows:

```
      CALL RAESEL(NCH,IRUN,IPASS,VMACH,FREQ,DISPL,ALPHA,RE,V
     1 ,CPST,VMST,CPMAG,CPPHASE,NUMP,STN,IFAULT)
C
C-- Arguments are as defined below (all except NCH must be variables):
C   Input values
C         NCH     channel number to be used for reading the input file
C         IRUN    Specifies the required run number.
C   Returned values
C         IPASS   The data recording pass for this run
C         VMACH   The Mach number for this run
C         FREQ    The oscillatory frequency for this run (Hz)
C         DISPL   The oscillation amplitude for this run (deg)
C         ALPHA   The steady incidence for this run (deg)
C         RE      The Reynolds number for this run
C         V       The airspeed for this run (m/s)
C   The following 4 quantities are arrays of values at each chordwise location
C   on the 1 or 2 chords for which data is given in this pass
C         CPST    Static pressure coefficients
C         VMST    Local Mach numbers
C         CPMAG   Oscillatory pressure coefficients magnitude
C         CPPHASE Oscillatory pressure coefficients phase angle (deg)
C
C         NUMP    The number of data points in the above arrays
C         STN     The chordwise locations of transducers (same on each chord)
C                 array of size 20
C         IFAULT  Indicator of any faulty transducers in this data set
C                 (see table 2).  Integer array size 40, array elements are
C                 set non-zero for faulty transducer positions
```

Sample data

Sample output from RAEPTR for the data of run 459 is given below.

RUN 459 M= 1.31 FREQ= 70.31 AMPLITUDE= .575 MEAN ALPHA= -2.16

stn	CP mag	CP phase	CP real	CP imag	CP steady
.015	2.6315	-32.6	2.2161	-1.4191	.1384
.025	2.7004	-31.2	2.3086	-1.4009	.0405
.050	2.2566	-29.1	1.9708	-1.0991	.0157
.100	1.4835	-28.2	1.3080	-.7000	.0879
.150	1.3652	-23.8	1.2494	-.5503	.0652
.200	1.2337	-20.0	1.1595	-.4214	-.0273
.250	1.2614	-16.7	1.2082	-.3623	-.0812
.300	1.1907	-14.2	1.1541	-.2930	-.1075
.350 F	.0982	-46.6	.0675	-.0713	.0042
.400	1.0141	-9.3	1.0007	-.1642	-.1608
.450	.9494	-10.9	.9323	-.1795	-.2019
.500	.9290	-6.9	.9223	-.1113	-.1699
.550	.9190	-7.1	.9119	-.1141	-.1427
.600	.9412	-12.6	.9186	-.2051	-.1333
.650	.7965	8.8	.7872	.1214	-.1557
.700	.7911	7.8	.7838	.1069	-.2055
.750	.8691	5.3	.8653	.0809	-.2070
.800	.8397	9.7	.8276	.1422	-.1573
.850 F	.8146	13.3	.7929	.1869	-.0426
.900	.8695	19.7	.8188	.2926	-.1339

FORMULARY

General Description of model

1.1	Designation	AGARD SMP Tailplane
1.2	Type	Low aspect ratio tailplane
1.3	Derivation	Planform used as standard configuration for prediction method evaluation
1.4	Additional remarks	
1.5	References	1

Model Geometry

2.1	Planform	Tapered low aspect ratio tailplane, see fig.1
2.2	Aspect ratio	2.42
2.3	Leading edge sweep	50.2°
2.4	Trailing edge sweep	14°
2.5	Taper ratio	0.27
2.6	Twist	0
2.7	Wing centreline chord	0.575m
2.8	Semi-span of model	0.442m
2.9	Area of planform	$0.161 m^2$
2.10	Location of reference sections and definition of profiles	NACA 64A010. See coordinates for 6 sections given in the data file RAEGEOM.DAT
2.11	Lofting procedure between reference sections	Constant section
2.12	Form of wing-body junction	None
2.13	Form of wing tip	Straight, no rounding
2.14	Control surface details	None

2.15	Additional remarks	For details of model structure see fig.2.
2.16	References	1

Wind Tunnel

3.1	Designation	RAE 3ft Tunnel
3.2	Type of tunnel	Transonic/supersonic
3.3	Test section dimensions	0.91m high, 0.64m wide
3.4	Type of roof and floor	Transonic: slotted; supersonic: closed
3.5	Type of side walls	Solid
3.6	Ventilation geometry	6% open area ratio
3.7	Thickness of side wall boundary layer	Not known
3.8	Thickness of boundary layers at roof and floor	Not known
3.9	Method of measuring Mach number	Sidewall static with a correction derived from calibration.
3.10	Flow angularity	Flow direction was considered to be the main factor in the observed angle of incidence for zero bending moment which varied from about +0.4° for M in range 0.65 to 0.9 to -0.4° for M=1.1 and 0° for M=1.2. Tests at zero mean aerodynamic incidence are included in the data, for comparison with the bulk of measurements which were made at zero mean geometric incidence. The geometric incidence for zero steady bending moment is given in table 1.
3.11	Uniformity of velocity over test section	Not known
3.12	Sources and levels of noise or turbulence in empty tunnel	See ref.2
3.13	Tunnel resonances	Significant preessure fluctuations at 3 Hz in subsonic tests
3.14	Additional remarks	For model installed in wind tunnel see fig.3.
3.15	References on tunnel	2, 3

Model motion

4.1	General description	Oscillated in pitch about an axis at 68.2% root chord.
4.2	Natural frequencies and normal modes of model and support system	Lowest frequency mode (fundamental bending) of model alone on fixed base 180 Hz, reduced to 120 Hz when model mounted on the drive system. This is significantly above the maximum oscillation frequency of 70 Hz.

Test Conditions

5.1	Model planform area/tunnel area	
5.2	Model span/tunnel height	0.486
5.3	Blockage	
5.4	Position of model in tunnel	Centrally mounted on side wall.
5.5	Range of velocities	
5.6	Range of tunnel total pressure	Tests presented here were all at 0.47 bar
5.7	Range of tunnel total temperature	Close to 293° K
5.8	Range of model steady or mean incidence	-5 to +5°
5.9	Definition of model incidence	Measured at root chord
5.10	Position of transition, if free	NA
5.11	Position and type of trip, if transition fixed	Band of ballotini 2mm wide at 0.075c. Ballotini diameter was 0.076mm for the subsonic and transonic tests (M<1.2) and 0.180mm for the supersonic tests.
5.12	Flow instabilities during tests	None recorded

5.13	Changes to mean shape of model due to steady aerodynamic load	Negligible
5.14	Additional remarks	-
5.15	References describing tests	1

Measurements and Observations

6.1	Steady pressures for the mean conditions	Y
6.2	Steady pressures for small changes from the mean conditions	N
6.3	Quasi-steady pressures	Y
6.4	Unsteady pressures	Y
6.5	Steady section forces for the mean conditions by integration of pressures	N
6.6	Steady section forces for small changes from the mean conditions by integration	N
6.7	Quasi-steady section forces by integration	N
6.8	Unsteady section forces by integration	N
6.9	Measurement of actual motion at points of model	N
6.10	Observation or measurement of boundary layer properties	N
6.11	Visualisation of surface flow	Y Visualisations made on prototype of the model (identical except for having only 2 pressure transducers). Sample visualisations are presented as data files VIS9A3, VIS9A5, VIS11A3, and VIS131A0. A sample is shown in fig. 4b (VIS9A5); note that these visualisations do not correspond to the conditions of specific test runs in the data.
6.12	Visualisation of shock wave movements	N
6.13	Aditional remarks	None

Instrumentation

7.1	Steady pressure	Measured with same transducers as unsteady pressure
	7.1.1 Position of orifices spanwise and chordwise	See 7.2.1
	7.1.2 Type of measuring system	See 7.2.3
7.2	Unsteady pressure	
	7.2.1 Position of orifices spanwise and chordwise	Instrumented sections on one surface at non-dimensional span η = 0.14, 0.42, 0.65, 0.84, 0.96. Each section has 20 chordwise measurement positions, at locations ξ = 0.015 0.025 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 Note that faults observed in specific transducers are recorded in table 2.
	7.2.2 Diameter of orifices	
	7.2.3 Type of measuring system	
	7.2.4 Type of transducers	Kulite pressure transducers type XCQL 093/25A mounted on lower surface of the model
	7.2.5 Principle and accuracy of calibration	Laboratory calibration as defined in ref.4
7.3	Model motion	
	7.3.1 Method of measuring motion reference coordinate	Steady incidence measured by a potentiometer on hydraulic actuator. Dynamic pitch amplitude derived from double integration of the signal from an accelerometer close to the model leading edge, see ref.1 appendix A.
	7.3.2 Method of determining spatial mode	Model distortion during the pitching excitation was assessed as

	of motion	very small by analysis
	7.3.3 Accuracy of measured motion	
7.4	Processing of unsteady measurements	
	7.4.1 Method of acquiring and processing measurements	Recorded on Presto system with capacity for 64 channel unsteady data. Note that to record data from all 5 sections runs were repeated three times (as shown in table 3, pass numbers 1, 2 ,3)
	7.4.2 Type of analysis	Harmonic analysis to give magnitude and phase angle of the unsteady pressure from each transducer.
	7.4.3 Unsteady pressure quantities obtained and accuracies achieved	Magnitude and phase of unsteady pressures. Repeatability very good for same conditions, $\pm$0.06 for both real and imaginary parts of CP
	7.4.4 Method of integration to obtain forces	NA
7.5	Additional remarks	No
7.6	References on techniques	4, 5

Data presentation

8.1	Test cases for which data could be made available	See table 3
8.2	Test cases for which data are included in this document	See table 4. The test points which are not included here are those cases assessed as having large wind tunnel interference, those with large model motion, the sweep excitations, and the 3 Hz runs in the transonic section. Note that some of the runs which are included here are for conditions above the buffet threshold indicated in fig.4 (marked B in table 4).
8.3	Steady pressures	CPST
8.4	Quasi-steady or steady perturbation pressures	No
8.5	Unsteady pressures	Given in data as magnitude CPMAG and phase angle CPPHASE A sample contour plot of local Mach number and pressure for sample zero incidence case is given in figure 7.
8.6	Steady forces or moments	No
8.7	Quasi-steady or unsteady perturbation forces	No
8.8	Unsteady forces and moments	Unsteady root strain rms values shown in figures 4, 5, 6
8.9	Other forms in which data could be made available	Original data available from the author for all runs listed in table 3 in the same format used here for the runs of table 4
8.10	Reference giving other representations of data	1

Comments on data

9.1	Accuracy	
	9.1.1 Mach number	
	9.1.2 Steady incidence	Of the order of $\pm 0.03°$
	9.1.3 Reduced frequency	
	9.1.4 Steady pressure coefficients	Pressure measurement repeatability about $\pm$0.002 at subsonic and transonic speeds, and about $\pm$0.006 at supersonic speeds
	9.1.5 Steady pressure derivatives	NA
	9.1.6 Unsteady pressure coefficients	Repeatability of real or imaginary components estimated as $\pm$0.06
9.2	Sensitivity to small changes of parameter	
9.3	Non-linearities	Minor effects found. Runs investigated the effects of oscillation amplitudes 0.4, 0.8, 1.2°.
9.4	Influence of tunnel total pressure	For a limited number of tests at $M=0.86$ $\alpha=0°$ the total pressure was increased by 50% (test 6). Both steady and unsteady measurements were virtually unaffected compared to the

		corresponding data for the regular total pressure.
9.5	Effects on data of uncertainty, or variation, in mode of model motion	For a pitch amplitude of 0.52°at M=0.86 the model distortion estimated to give an incidence of 0.03° at the wing tip for the worst-case frequency of 70 Hz.
9.6	Wall interference corrections	-
9.7	Other relevant tests on same model	The model was also tested in the 1m Tunnel at Göttingen
9.8	Relevant tests on other models of nominally the same shapes	-
9.9	Any remarks relevant to comparison between experiment and theory	-
9.10	Additional remarks	-
9.11	References on discussion of data	1

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List of references

1 D G Mabey, B L Welsh and B E Cripps. Measurements of steady and oscillatory pressures on a low aspect ratio model at subsonic and supersonic speeds. RAE TR 98095, 1984

2 D G Mabey. Flow unsteadiness in the new perforated working section of the 3ftx3ft tunnel. 1968

3 E P Sutton et al. Performance of the 3x2.9ft slotted transonic working section of the RAE Bedford 3ft wind tunnel. ARC R&M 3228.

4 B.L. Welsh, D.M. McOwat. Presto: a system for the measurement and analysis of time-dependent signals. RAE Technical Report 79135 (1979)

5 B.L. Welsh. A method to improve the temperature stability of semi-conductor strain gauge pressure transducers. RAE Technical Report 77155 (1977)

Table 1 Geometric incidence for zero steady bending moment

M	α	M	α
0.65	-0.31	1.10	+0.21
0.80	-0.31	1.20	0
0.86	-0.41	1.32	-0.1
0.90	-0.41	1.52	+0.2
0.95	-0.40	1.62	+0.1
1.05	+0.41	1.72	+0.1

Table 2 Pressure transducer faults

Transducer or cable faults were noted for the following conditions:

Run numbers	Section	η	ξ
1 to 353 (slotted transonic section)	1	0.14	0.35, 0.85
	2	0.42	0.40, 0.90
	3	0.65	0.20, 0.85
	4	0.84	0.45, 0.60(intermittent), 0.85
	5	0.96	-
354 to 499 (closed supersonic section)	1	0.14	0.35, 0.85
	2	0.42	0.40
	3	0.65	0.20, 0.85
	4	0.84	0.45, 0.60
	5	0.96	0.60, 0.80

Table 3 Tests for which data is available

Tests 1 to 6 — Slotted transonic section, Tests 7 to 10 — Closed supersonic section
Nominal Reynolds number $3*10^6$ for all tests except Test 6 at $4.5*10^6$

TEST 1 ZERO GEOMETRIC INCIDENCE

α	M	δ	f	Data points for sections 1 pass 3	2&3 pass 1	4&5 pass 2
0	0.65	0	0	238	136	2/7
0	0.65	0.4	3	239	137	—
0	0.65	0.4	12	240	138	3/9
0	0.65	0.4	33	241	139	4/10
0	0.65	0.4	70	242	140	5/11
0	0.65	0.4	S	243	141	6/12
0	0.80	0	0	244	142	13
0	0.80	0.4	3	245	143	14
0	0.80	0.4	12	246	144	15
0	0.80	0.4	33	247	145	16
0	0.80	0.4	70	248	146	17
0	0.80	0.4	S	249	147	18
0	0.86	0	0	250	148	19/55
0	0.86	0.4	3	251	149	20/56
0	0.86	0.4	12	252	150	21/57
0	0.86	0.4	33	253	151	22/58
0	0.86	0.4	70	254	152	23/59
0	0.86	0.4	S	255	153	24
0	0.90	0	0	256	154	25
0	0.90	0.4	3	257	155	26
0	0.90	0.4	12	258	156	27
0	0.90	0.4	33	259	157	28
0	0.90	0.4	70	260	158	29
0	0.90	0.4	S	261	159	30
0	0.95	0	0	262	160	31
0	0.95	0.4	3	263	161	32
0	0.95	0.4	12	264	162	33
0	0.95	0.4	33	265	163	34
0	0.95	0.4	70	266	164	35
0	0.95	0.4	S	267	165	36
0	1.05**	0	0	268	166	37
0	1.05**	0.4	3	269	167	38
0	1.05**	0.4	12	270	168	39
0	1.05**	0.4	33	271	169	40
0	1.05**	0.4	70	272	170	41
0	1.05**	0.4	S	273	171	42
0	1.10**	0	0	274	172	43
0	1.10**	0.4	3	275	173	44
0	1.10**	0.4	12	276	174	45
0	1.10**	0.4	33	277	175	46
0	1.10**	0.4	70	278	176	47
0	1.10**	0.4	S	279	177	48
0	1.20	0	0	280	178	49
0	1.20	0.4	3	281	179	50
0	1.20	0.4	12	282	180	51
0	1.20	0.4	33	283	181	52
0	1.20	0.4	70	284	182	53
0	1.20	0.4	S	285	183	54

TEST 1A ZERO AERODYNAMIC INCIDENCE

-0.37	0.86	0	0	332	190	—
-0.37	0.86	0.4	3	333	191	—
-0.37	0.86	0.4	12	334	192	—
-0.37	0.86	0.4	33	335	193	—
-0.37	0.86	0.4	70	336	194	—

Table 3 continued Tests for which data is available

Tests 1 to 6 — Slotted transonic section, Tests 7 to 10 — Closed supersonic section
Nominal Reynolds number $3*10^6$ for all tests except Test 6 at $4.5*10^6$

TEST 1B ZERO AERODYNAMIC INCIDENCE

α	M	δ	f	Data points for sections 1 pass 3	2&3 pass 1	4&5 pass 2
-0.37	0.86	0.4	S	340	—	—
-0.37	0.86	0.8	S	341*	—	—
TEST 2 +2° GEOMETRIC INCIDENCE						
+2	0.86	0	0	286	196	62
+2	0.86	0.4	3	287	197	63/74
+2	0.86	0.4	12	288	198	64
+2	0.86	0.4	33	289	199	65
+2	0.86	0.4	70	290	200	66
+2	0.86	0.4	S	291	201	67
-2	0.86**	0	0	292	202	68
-2	0.86**	0.4	3	293	203	69/77
-2	0.86**	0.4	12	294	204	70
-2	0.86**	0.4	33	295	205	71/72
-2	0.86**	0.4	70	296	206	90
-2	0.86**	0.4	S	297	207	73
TEST 3 TEST OF LINEARITY						
+2	0.86	0.4	3	298	208	74/63
+2	0.86	0.8	3	299	209	75
+2	0.86	1.2	3	300	210	76
+2	0.86	0.4	12	301	211	86
+2	0.86	0.8	12	302	212	87
-2	0.86**	0.4	3	303	216	77
-2	0.86**	0.8	3	304	217	78
-2	0.86**	1.2	3	305	218	79
-2	0.86**	0.4	12	306	219	88
-2	0.86**	0.8	12	307	220	89
TEST 4 ±4° GEOMETRIC INCIDENCE						
+4	0.86	0	0	308	—	80
+4	0.86	0.4	3	309	221	81
+4	0.86	0.4	S	310	222	82
-4	0.86**	0	0	311	—	83
-4	0.86**	0.4	3	312	223	84
-4	0.86**	0.4	S	313	224	85

Table 3 continued Tests for which data is available

Tests 1 to 6 — Slotted transonic section, Tests 7 to 10 — Closed supersonic section
Nominal Reynolds number 3*10[6] for all tests except Test 6 at 4.5*10[6]

TEST 5 ±5° GEOMETRIC INCIDENCE

α	M	δ	f	Data points for sections 1 pass 3	2&3 pass 1	4&5 pass 2
+5	0.65	0	0	—	—	92
+5	0.65	0.4	3	—	—	93
+5	0.65	0.4	12	—	—	94
+5	0.65	0.4	33	—	—	95
+5	0.65	0.4	70	—	—	96
+5	0.65	0.4	S	—	—	97
+5	0.80	0	0	—	—	105
+5	0.80	0.4	3	—	—	106
+5	0.80	0.4	12	—	—	107
+5	0.80	0.4	33	—	—	108
+5	0.80	0.4	70	—	—	109
+5	0.80	0.4	S	—	—	110
+5	0.86	0	0	314	225	117
+5	0.86	0.4	3	315	226	118
+5	0.86	0.4	12	316	227	119
+5	0.86	0.4	33	317	228	120
+5	0.86	0.4	70	318	229	121
+5	0.86	0.4	S	319	230	122
-5	0.65	0	0	—	—	98
-5	0.65	0.4	3	—	—	99
-5	0.65	0.4	12	—	—	100
-5	0.65	0.4	33	—	—	101
-5	0.65	0.4	70	—	—	102
-5	0.65	0.4	S	—	—	103/104
-5	0.80	0	0	—	—	111
-5	0.80	0.4	3	—	—	112
-5	0.80	0.4	12	—	—	113
-5	0.80	0.4	33	—	—	114
-5	0.80	0.4	70	—	—	115
-5	0.80	0.4	S	—	—	116
-5	0.86**	0	0	326	231	123
-5	0.86**	0.4	3	327	232	124
-5	0.86**	0.4	12	328	233	125
-5	0.86**	0.4	33	329	234	126
-5	0.86**	0.4	70	330	235	127
-5	0.86**	0.4	S	331	236	—

TEST 6 ZERO GEOMETRIC INCIDENCE — HIGH REYNOLDS NUMBER

0	0.86	0	0	348	—	129
0	0.86	0.4	3	349	—	130
0	0.86	0.4	12	350	—	131
0	0.86	0.4	33	351	—	132
0	0.86	0.4	70	352	—	133
0	0.86	0.4	S	353	—	134/13

Table 3 continued Tests for which data is available

Tests 1 to 6 — Slotted transonic section, Tests 7 to 10 — Closed supersonic section
Nominal Reynolds number $3*10^6$ for all tests except Test 6 at $4.5*10^6$

TEST 7 M = 1.32

				Data points for sections		
α	M	δ	f	1 pass 3	2&3 pass 1	4&5 pass 2
-0.13	1.32	0.4	3	456	410	354
-0.13	1.32	0.4	12	462	411	355
-0.13	1.32	0.4	33	466	412	356
-0.13	1.32	0.4	70	460	413	357
1.87	1.32	0.4	3	457	414/416	358
1.87	1.32	0.4	12	463	415	359
1.87	1.32	0.4	33	467	—	360
1.87	1.32	0.4	70	461	419	361
-2.13	1.32	0.4	3	458	420	362
-2.13	1.32	0.4	12	464	421	363
-2.13	1.32	0.4	33	465	417	364
-2.13	1.32	0.4	70	459	418	365
4.87	1.32	0.4	3	468	422	366
4.87	1.32	0.4	12	472	425	367
4.87	1.32	0.4	33	475	426	—
4.87	1.32	0.4	70	471	429	369
-5.13	1.32	0.4	3	469	423	370
-5.13	1.32	0.4	12	473	424	371
-5.13	1.32	0.4	33	474	427	—
-5.13	1.32	0.4	70	470	428	373

TEST 8 M = 1.52

0	1.52	0.4	3	476	432	374
0	1.52	0.4	12	482	438	375
0	1.52	0.4	33	486	441	376
0	1.52	0.4	70	480	435	377
+5	1.52	0.4	3	477	433	378
+5	1.52	0.4	12	483	439	379
+5	1.52	0.4	33	487	442	380
+5	1.52	0.4	70	481	436	381
-5	1.52	0.4	3	478	434	382
-5	1.52	0.4	12	484	440	383
-5	1.52	0.4	33	485	443	384
-5	1.52	0.4	70	479	437	385

TEST 9 M = 1.62

0	1.62	0.4	3	—	—	386
0	1.62	0.4	12	—	—	387
0	1.62	0.4	33	—	—	388
0	1.62	0.4	70	—	—	389
+5	1.62	0.4	3	—	—	390
+5	1.62	0.4	12	—	—	391
+5	1.62	0.4	33	—	—	392
+5	1.62	0.4	70	—	—	393
-5	1.62	0.4	3	—	—	394
-5	1.62	0.4	12	—	—	395
-5	1.62	0.4	33	—	—	396
-5	1.62	0.4	70	—	—	397

Table 3 continued Tests for which data is available

Tests 1 to 6 — Slotted transonic section, Tests 7 to 10 — Closed supersonic section

TEST 10 M = 1.72

α	M	δ	f	Data points for sections 1 pass 3	2&3 pass 1	4&5 pass 2
0	1.72	0.4	3	488	444	398
0	1.72	0.4	12	494	450	399
0	1.72	0.4	33	498	454	400
0	1.72	0.4	70	492	448	401
+5	1.72	0.4	3	489	445	402
+5	1.72	0.4	12	495	451	403
+5	1.72	0.4	33	499	455	404
+5	1.72	0.4	70	493	449	405
-5	1.72	0.4	3	490	446	406
-5	1.72	0.4	12	496	452	407
-5	1.72	0.4	33	497	453	408
-5	1.72	0.4	70	491	447	409

* Very large model amplitude
** Tunnel interference serious
S Denotes frequency sweep, from 5 to 75 Hz in 10 sec. Logarithmic sweep up to run 85, Linear sweep from run 116

Table 4 Tests for which data is presented in this report

Tests 1 to 6 — Slotted transonic section, Tests 7 to 10 — Closed supersonic section
Nominal Reynolds number 3*10^6 for all tests except Test 6 at 4.5*10^6

TEST 1 ZERO GEOMETRIC INCIDENCE

α	M	δ	f	Data points for sections 1 pass 3	2&3 pass 1	4&5 pass 2
0	0.65	0	0	238	136	2/7
0	0.65	0.4	12	240	138	3/9
0	0.65	0.4	33	241	139	4/10
0	0.65	0.4	70	242	140	5/11
0	0.80	0	0	244	142	13
0	0.80	0.4	12	246	144	15
0	0.80	0.4	33	247	145	16
0	0.80	0.4	70	248	146	17
0	0.86	0	0	250	148	19/55
0	0.86	0.4	12	252	150	21/57
0	0.86	0.4	33	253	151	22/58
0	0.86	0.4	70	254	152	23/59
0	0.90	0	0	256	154	25
0	0.90	0.4	12	258	156	27
0	0.90	0.4	33	259	157	28
0	0.90	0.4	70	260	158	29
0	0.95	0	0	262	160	31
0	0.95	0.4	12	264	162	33
0	0.95	0.4	33	265	163	34
0	0.95	0.4	70	266	164	35
0	1.20	0	0	280	178	49
0	1.20	0.4	12	282	180	51
0	1.20	0.4	33	283	181	52
0	1.20	0.4	70	284	182	53
TEST 1A ZERO AERODYNAMIC INCIDENCE						
-0.37	0.86	0	0	332	190	—
-0.37	0.86	0.4	12	334	192	—
-0.37	0.86	0.4	33	335	193	—
-0.37	0.86	0.4	70	336	194	—
TEST 1B ZERO AERODYNAMIC INCIDENCE						
-0.37	0.86	0.4	33	337	—	—
-0.37	0.86	0.8	33	338	—	—
-0.37	0.86	1.2	33	339	—	—
TEST 2 +2° GEOMETRIC INCIDENCE						
+2	0.86	0	0	286	196	62
+2	0.86	0.4	12	288	198	64
+2	0.86	0.4	33	289	199	65
+2	0.86	0.4	70	290	200	66
TEST 4 4° GEOMETRIC INCIDENCE						
+4 B	0.86	0	0	308	—	80
+4 B	0.86	0.4	3	309	221	81

Table 4 continued Tests for which data is presented in this report

Tests 1 to 6 — Slotted transonic section, Tests 7 to 10 — Closed supersonic section
Nominal Reynolds number 3*10^6 for all tests except Test 6 at 4.5*10^6

TEST 5 ±5^O GEOMETRIC INCIDENCE

α	M	δ	f	Data points for sections 1 pass 3	2&3 pass 1	4&5 pass 2
+5	0.65	0	0	—	—	92
+5	0.65	0.4	12	—	—	94
+5	0.65	0.4	33	—	—	95
+5	0.65	0.4	70	—	—	96
+5	0.80	0	0	—	—	105
+5	0.80	0.4	12	—	—	107
+5	0.80	0.4	33	—	—	108
+5	0.80	0.4	70	—	—	109
+5	B 0.86	0	0	314	225	117
+5	B 0.86	0.4	12	316	227	119
+5	B 0.86	0.4	33	317	228	120
+5	B 0.86	0.4	70	318	229	121
-5	0.65	0	0	—	—	98
-5	0.65	0.4	12	—	—	100
-5	0.65	0.4	33	—	—	101
-5	0.65	0.4	70	—	—	102
-5	0.80	0	0	—	—	111
-5	0.80	0.4	12	—	—	113
-5	0.80	0.4	33	—	—	114
-5	0.80	0.4	70	—	—	115

TEST 6 ZERO GEOMETRIC INCIDENCE — HIGH REYNOLDS NUMBER

0	0.86	0	0	348	—	129
0	0.86	0.4	12	350	—	131
0	0.86	0.4	33	351	—	132
0	0.86	0.4	70	352	—	133

TEST 7 M = 1.32

-0.13	1.32	0.4	3	456	410	354
-0.13	1.32	0.4	12	462	411	355
-0.13	1.32	0.4	33	466	412	356
-0.13	1.32	0.4	70	460	413	357
1.87	1.32	0.4	3	457	414/416	358
1.87	1.32	0.4	12	463	415	359
1.87	1.32	0.4	33	467	—	360
1.87	1.32	0.4	70	461	419	361
-2.13	1.32	0.4	3	458	420	362
-2.13	1.32	0.4	12	464	421	363
-2.13	1.32	0.4	33	465	417	364
-2.13	1.32	0.4	70	459	418	365
4.87	1.32	0.4	3	468	422	366
4.87	1.32	0.4	12	472	425	367
4.87	1.32	0.4	33	475	426	—
4.87	1.32	0.4	70	471	429	369
-5.13	1.32	0.4	3	469	423	370
-5.13	1.32	0.4	12	473	424	371
-5.13	1.32	0.4	33	474	427	—
-5.13	1.32	0.4	70	470	428	373

Table 4 continued Tests for which data is presented in this report

Tests 1 to 6 — Slotted transonic section, Tests 7 to 10 — Closed supersonic section
Nominal Reynolds number $3*10^6$ for all tests except Test 6 at $4.5*10^6$

TEST 8 M = 1.52

α	M	δ	f	Data points for sections 1 pass 3	2&3 pass 1	4&5 pass 2
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0	1.52	0.4	12	482	438	375
0	1.52	0.4	33	486	441	376
0	1.52	0.4	70	480	435	377
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+5	1.52	0.4	12	483	439	379
+5	1.52	0.4	33	487	442	380
+5	1.52	0.4	70	481	436	381
-5	1.52	0.4	3	478	434	382
-5	1.52	0.4	12	484	440	383
-5	1.52	0.4	33	485	443	384
-5	1.52	0.4	70	479	437	385

TEST 9 M = 1.62

α	M	δ	f	1 pass 3	2&3 pass 1	4&5 pass 2
0	1.62	0.4	3	—	—	386
0	1.62	0.4	12	—	—	387
0	1.62	0.4	33	—	—	388
0	1.62	0.4	70	—	—	389
+5	1.62	0.4	3	—	—	390
+5	1.62	0.4	12	—	—	391
+5	1.62	0.4	33	—	—	392
+5	1.62	0.4	70	—	—	393
-5	1.62	0.4	3	—	—	394
-5	1.62	0.4	12	—	—	395
-5	1.62	0.4	33	—	—	396
-5	1.62	0.4	70	—	—	397

TEST 10 M = 1.72

α	M	δ	f	1 pass 3	2&3 pass 1	4&5 pass 2
0	1.72	0.4	3	488	444	398
0	1.72	0.4	12	494	450	399
0	1.72	0.4	33	498	454	400
0	1.72	0.4	70	492	448	401
+5	1.72	0.4	3	489	445	402
+5	1.72	0.4	12	495	451	403
+5	1.72	0.4	33	499	455	404
+5	1.72	0.4	70	493	449	405
-5	1.72	0.4	3	490	446	406
-5	1.72	0.4	12	496	452	407
-5	1.72	0.4	33	497	453	408
-5	1.72	0.4	70	491	447	409

B : runs at conditions above the onset of Buffet as given in fig.4

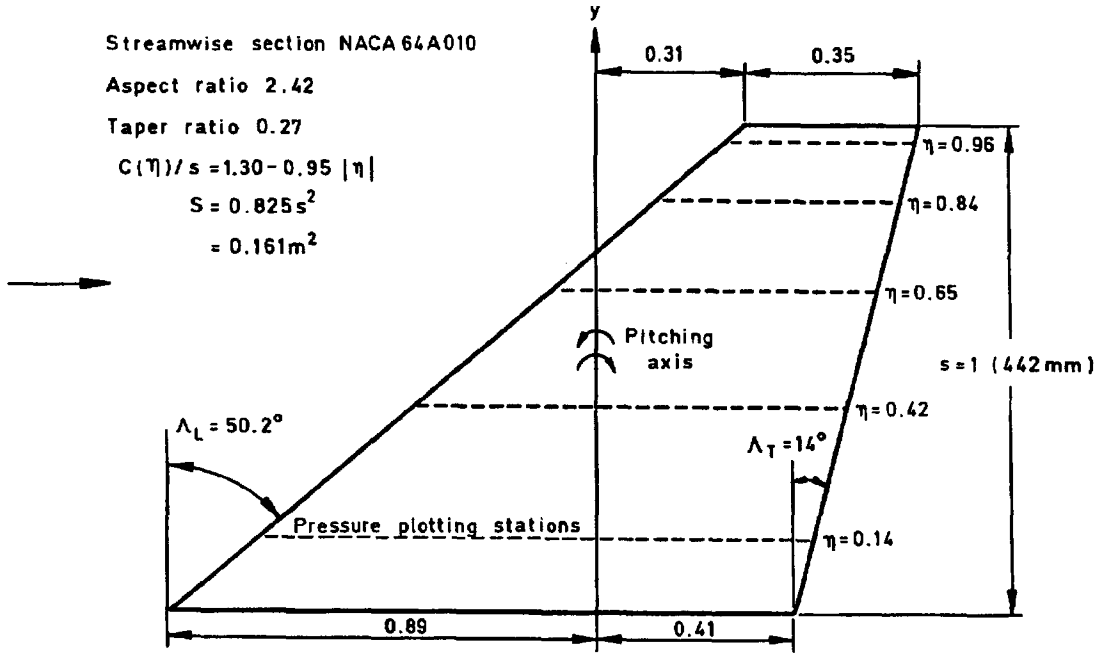


Fig.1 Planform of model (AGARD SMP tailplane)

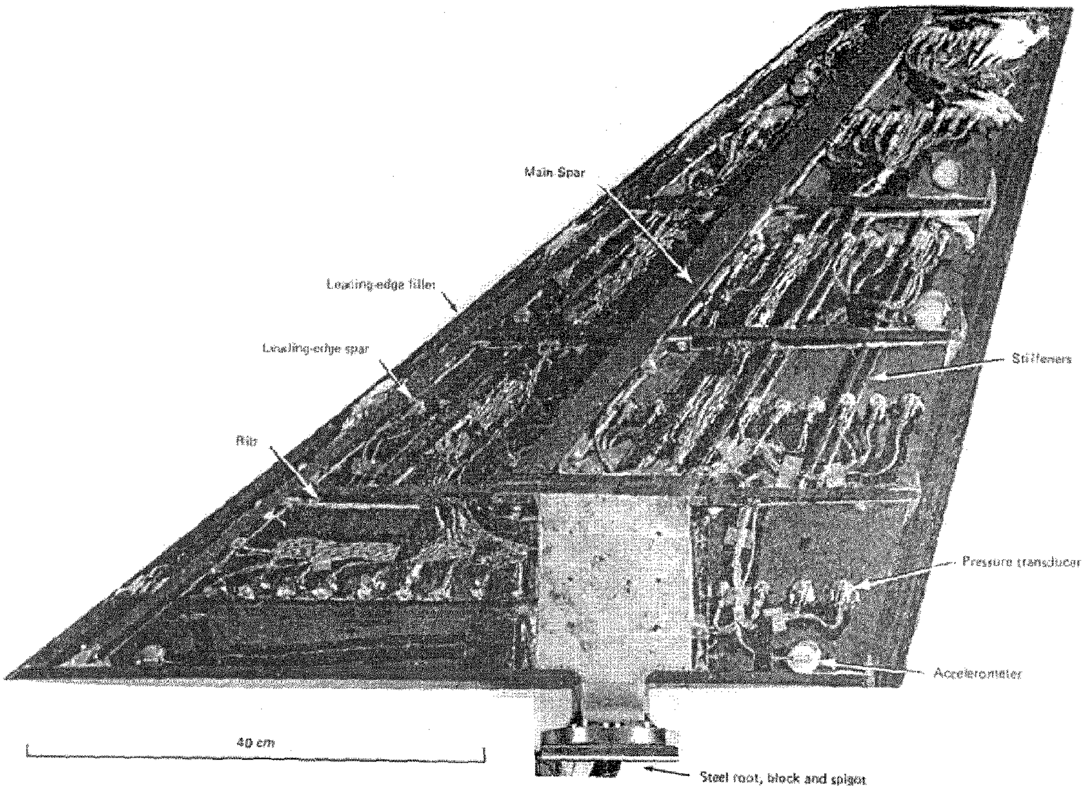


Fig.2 Interior of model

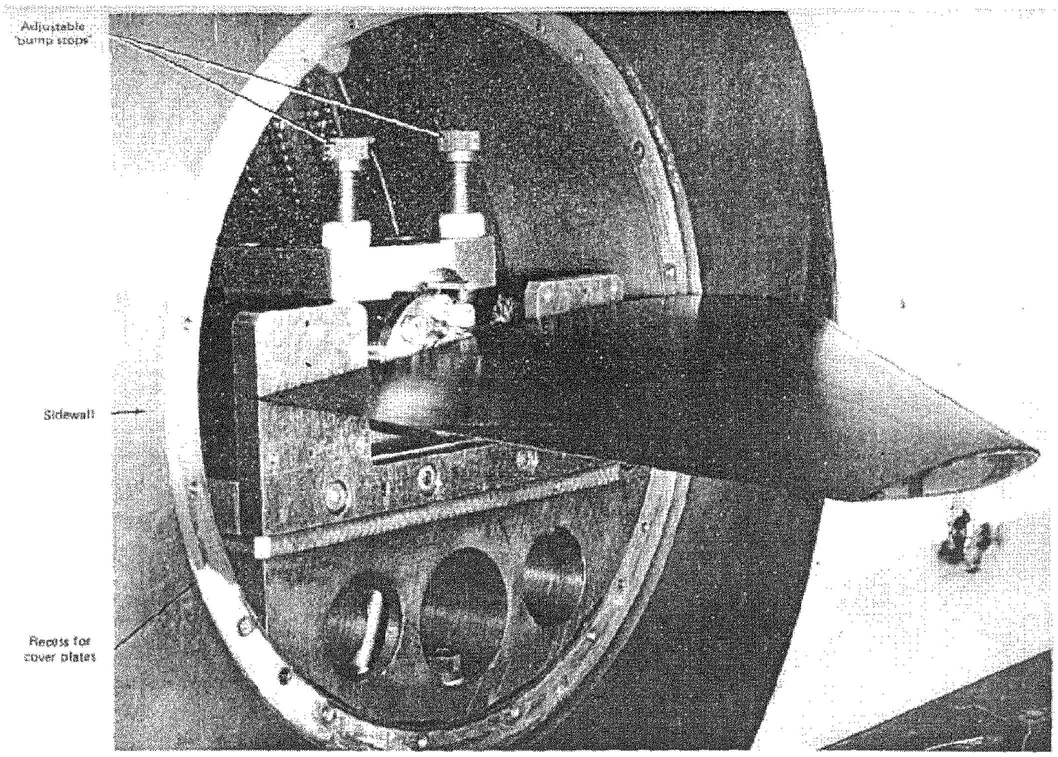


Fig.3 Model installed in top and bottom slotted section of RAE 3ft tunnel

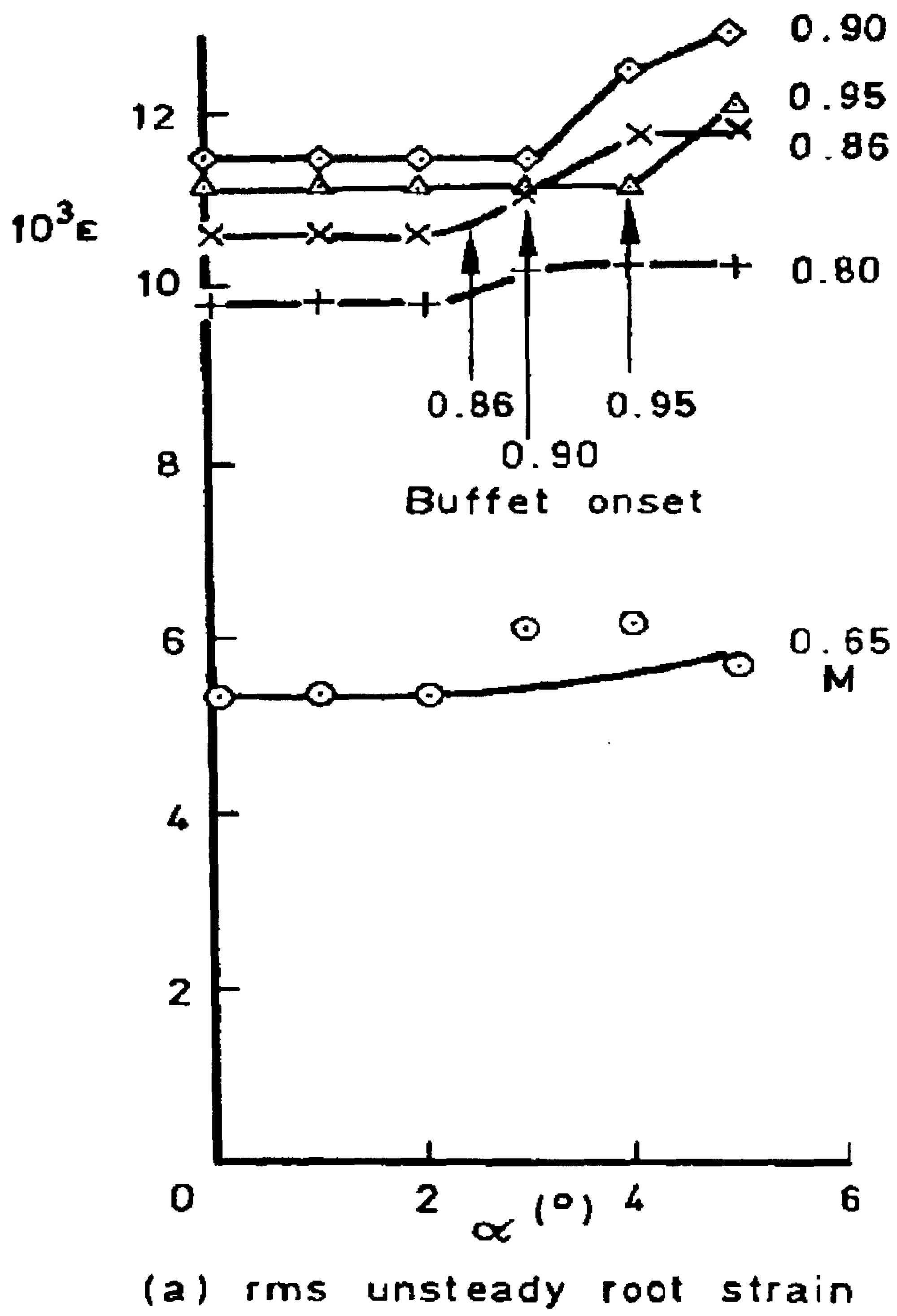
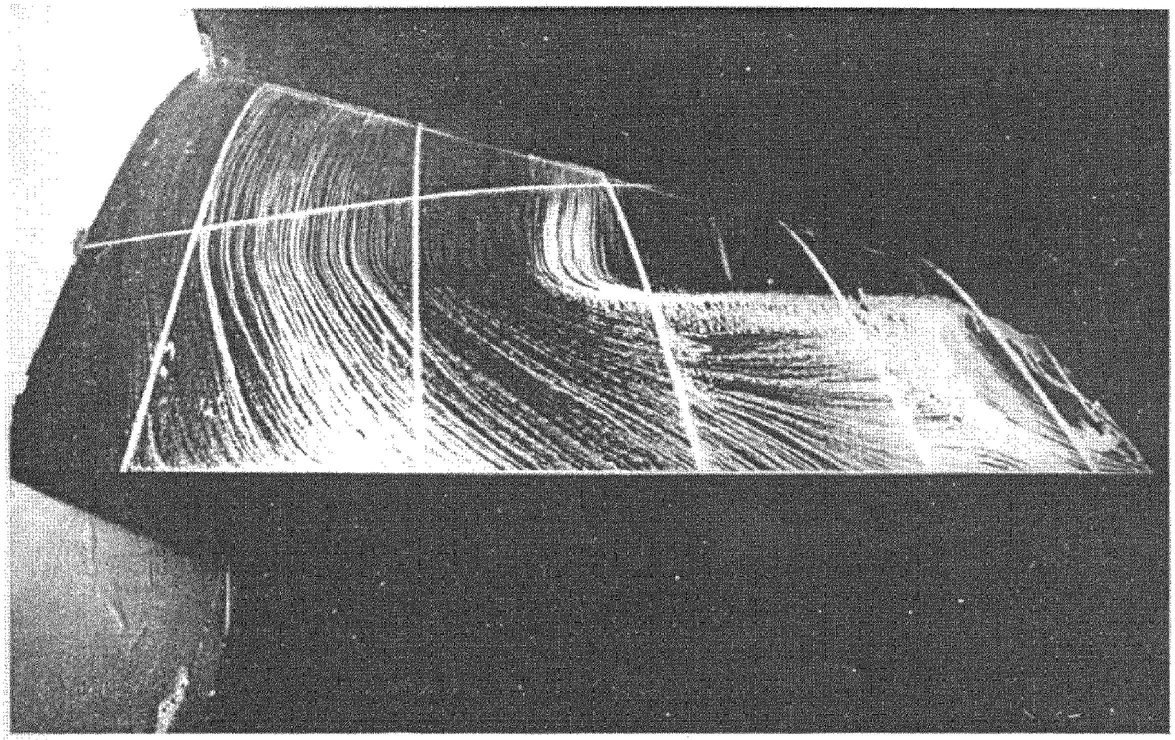
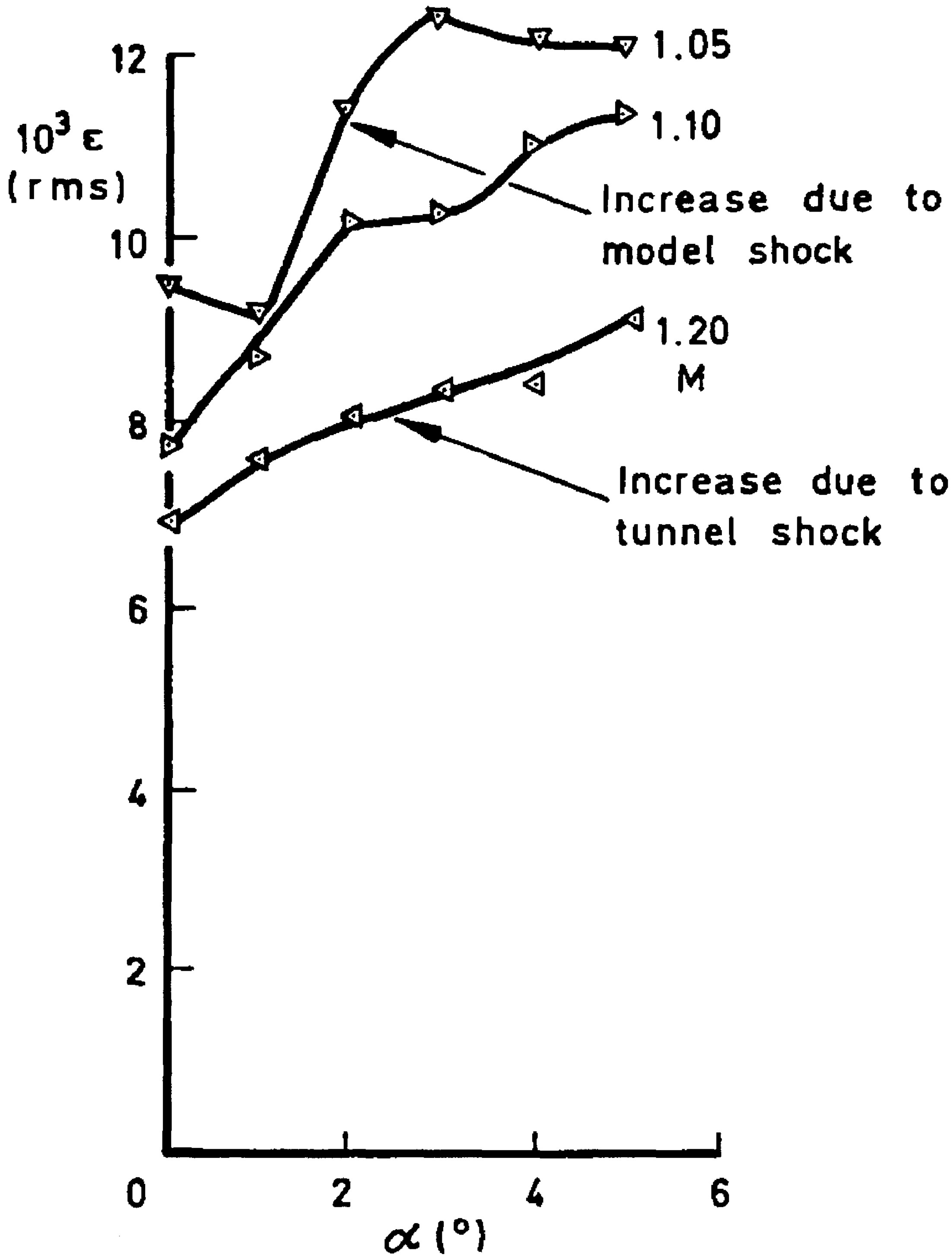


Fig.4 Slotted section - subsonic and transonic speeds. Unsteady root strain and flow visualisation v incidence and Mach number



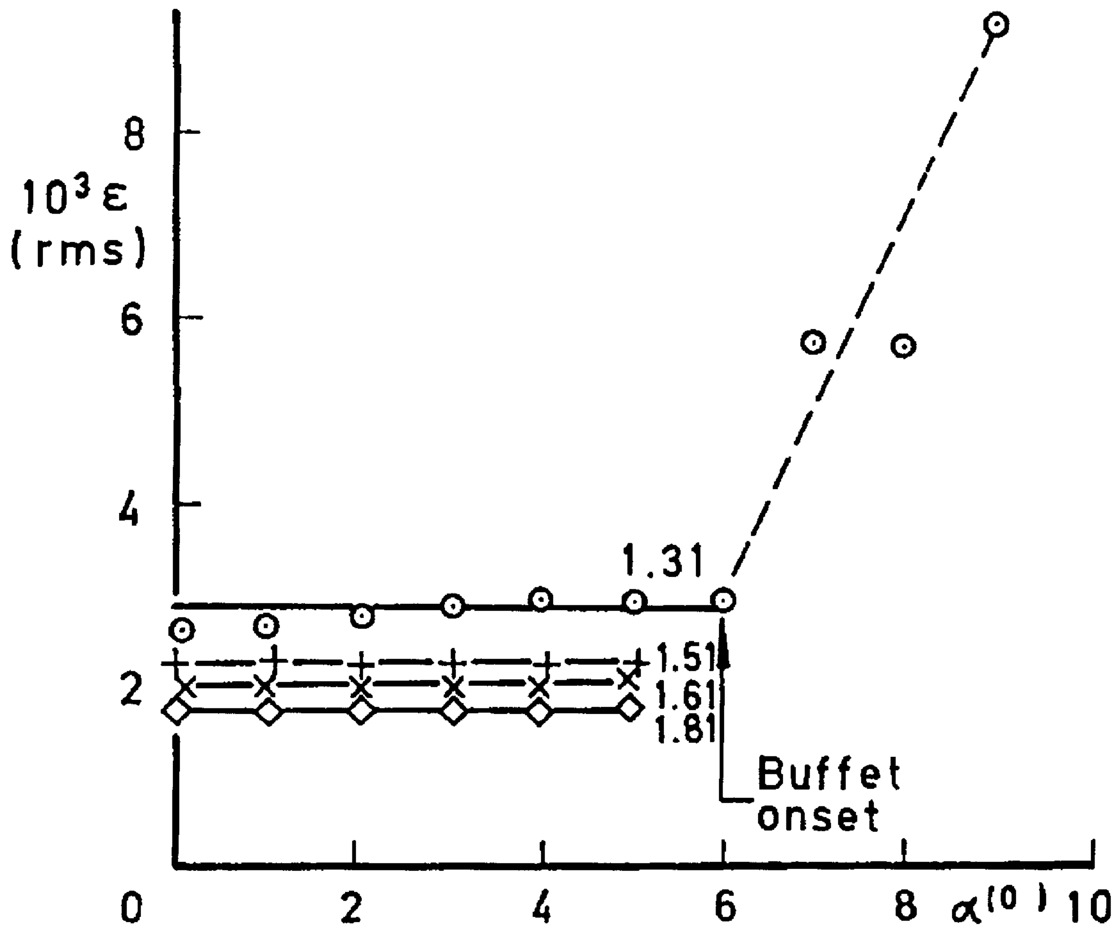
Flow visualisation, M = 0.90, α = 5°

Fig. 4b



(a) rms unsteady root strain

Fig. 5 Slotted section - supersonic speeds. Unsteady root strain and flow visualisation v incidence and Mach number



(a) rms unsteady root strain

Fig. 6 Closed section - supersonic speeds. Unsteady root strain and flow visualisation

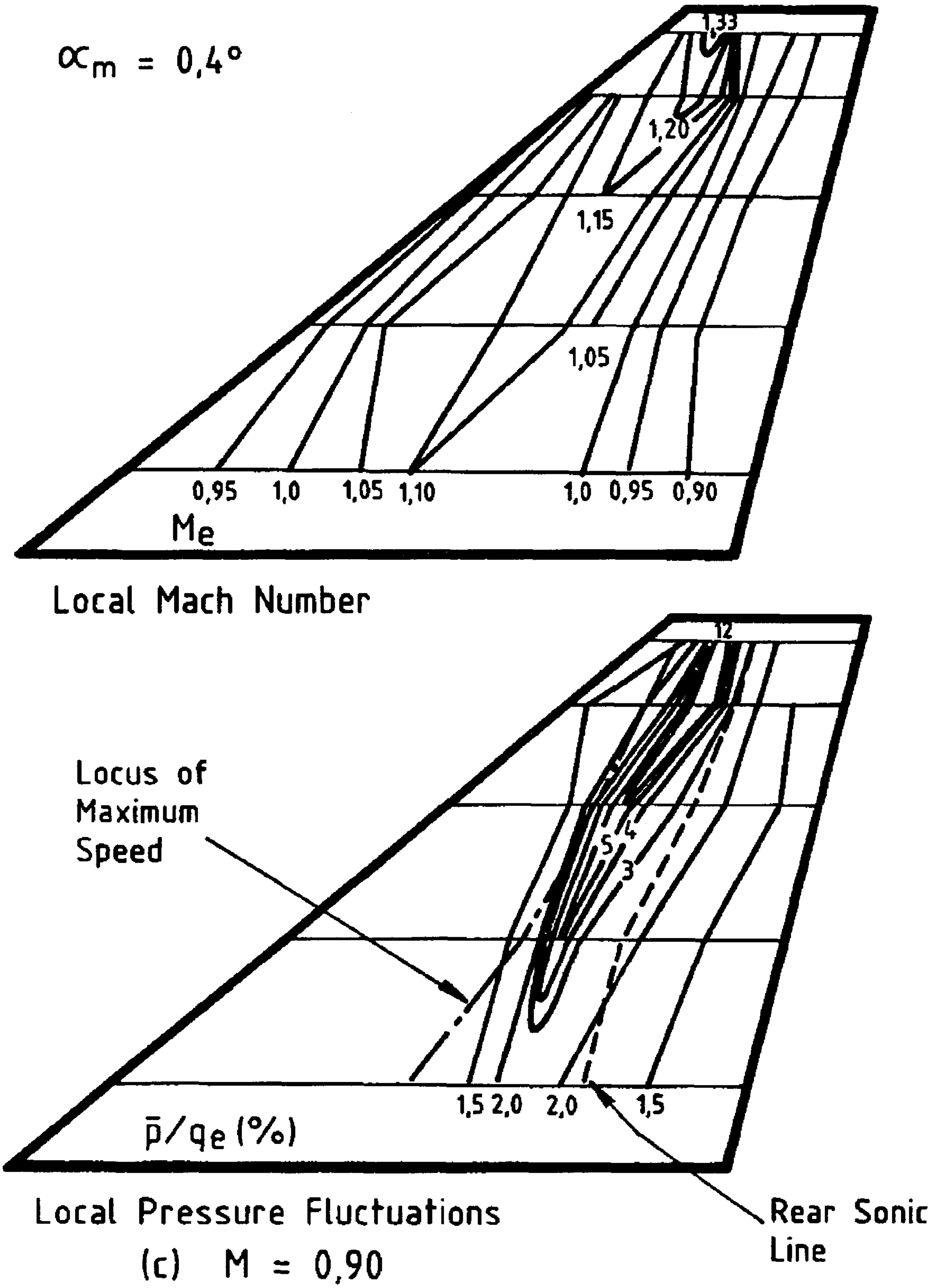


Fig. 7 Contour plots of local Mach numbers and rms pressure fluctuations at transonic speeds at α=0°