AEDC-TR-76-117

EVALUATION OF AN INTERNAL BALANCE-SUPPORTING BRACKET SIMULATING LUG SUSPENSION FOR CAPTIVE STORES IN WIND TUNNEL TESTS

PROPULSION WIND TUNNEL FACILITY
ARNOLD ENGINEERING DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
ARNOLD AIR FORCE STATION, TENNESSEE 37389

October 1976

Final Report for Period September 1975 – June 1976

Approved for public release; distribution unlimited.

Prepared for

AIR FORCE ARMAMENT LABORATORY (DLJC)
EGLIN AIR FORCE BASE, FLORIDA 32542

NOTICES

APPROVAL STATEMENT

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

Kenneth B. Harwood

KENNETH B. HARWOOD
Major, CF
Research & Development
Division
Directorate of Technology

Robert O. Dietz

ROBERT O. DIETZ
Director of Technology

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AEDC-TR-76-117	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EVALUATION OF AN INTERNAL BALANCE-SUPPORTING BRACKET SIMULATING LUG SUSPENSION FOR CAPTIVE STORES IN WIND TUNNEL TESTS		5. TYPE OF REPORT & PERIOD COVERED Final Report - September 1975 - June 1976
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. E. Dix - ARO, Inc.		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Arnold Engineering Development Center (DY) Air Force Systems Command Arnold Air Force Station, Tennessee 37389		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Program Element 62602F Project 2567
11. CONTROLLING OFFICE NAME AND ADDRESS Arnold Engineering Development Center(DYFS) Air Force Systems Command Arnold Air Force Station, Tennessee 37389		12. REPORT DATE October 1976
		13. NUMBER OF PAGES 53
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available in DDC

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

wind tunnel	F-4C
model tests	aircraft (parent)
support	internal
aerodynamic	loads (forces)
store (captive)	suspension devices

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Wind tunnel measurements of the aerodynamic loads acting on two store configurations supported in the external captive position on a 1/20-scale model of the F-4C aircraft have been made. The store models represented stable and unstable pylon-mounted configurations. Six components of forces and moments were measured using an internal strain-gage balance supported by a bracket extending through the upper surface of the store and attached firmly to the

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

20. ABSTRACT (Continued)

left inboard pylon of the aircraft. Two designs of bracket were used, one a solid blade with the appearance of an extension of the pylon, and the other fabricated to the same dimensions but "ventilated" by cutting a slot through the solid blade so that the remaining bracket material simulated suspension lugs. Measurable differences in forces and moments acting in the longitudinal plane of the store were detected for both stable and unstable stores. From an analysis of the force and moment measurements, it is probable that the pressure distribution over the after portion of a store is altered when using the ventilated bracket.

AFSC
Arnold AFB Tenn

PREFACE

The work reported herein was conducted at the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), at the request of the Air Force Armament Laboratory (AFATL), under Program Element 62602F, Project 2567. The monitor of the project was Lt. Norman O. Speakman, AFATL (DLJC). The results were obtained by ARO, Inc. (a subsidiary of Sverdrup & Parcel and Associates, Inc.), contract operator of AEDC, AFSC, Arnold Air Force Station, Tennessee. The work was accomplished under ARO Project No. P34A-C4A. Wind tunnel testing was conducted by T. O. Shadow, and the author of this report was R. E. Dix, ARO, Inc. Analysis of the data was completed in June 1976, and the manuscript (ARO Control No. ARO-PWT-TR-76-71) was submitted for publication on July 7, 1976.

CONTENTS

ILLUSTRATIONS

1.0 INTRODUCTION

Many techniques have been used in wind tunnels to support models of external stores in the captive position on an aircraft for the measurement of the aerodynamic loads acting on the store. With the exception of magnetic suspension, these techniques may be categorized as examples of either the internal-bracket support or dual-support methods, as illustrated in Fig. 1. Recently, in the Propulsion Wind Tunnel Facility (PWT) at the Arnold Engineering Development Center (AEDC), a study was conducted to evaluate possible influences on captive store loads data introduced by conventional applications of the two principal methods of supporting the store. Three principal influences were specifically investigated: the effect of the presence of a sting, the effect of altering the afterbody of a store to allow mounting on a sting, and the effect of supporting the store model in an incorrect captive position because of the need to maintain a gap between the store model and the correct captive location on the aircraft model to prevent fouling. The first two of these effects were treated in Ref. 1 for eight examples of stable, unstable, pylon-mounted, and rack-mounted stores. Gap effects were treated in a separate publication (Ref. 2).

For the study of gap effects, aerodynamic loads acting on the store models in the captive position were measured using both of the techniques illustrated in Fig. 1, i.e, with the store model firmly attached to the pylon or rack with a bracket, and with the store supported on a separate sting, avoiding contact with the aircraft model. Comparisons of both sets of data revealed very good agreement, for the most part. In some cases, however, there were significant differences in the captive position loads that did not appear to be solely attributable to use of the dual-support technique. Therefore, attention was directed to possible influences of the other technique, i.e., the bracket-supported technique.

Balance-supporting brackets often have the appearance of solid blades or fins protruding through the upper surface of the store model. At least two characteristics of such an installation can affect measurements of aerodynamic loads acting on the captive store. First, cutting a slot in the upper surface of the store model to provide clearance around the bracket results in a reduction of surface area over which pressures would normally be distributed. Second, if the axial dimension of the bracket is large, the bracket can have the same effect on the development of the flow as an extension of the pylon, especially with respect to crossflow characteristics. Although nothing can be done about the first effect, i.e., the removal of material from the upper surface of the store model to clear the bracket, the effect of extending the pylon can be evaluated in a straightforward manner. Actual suspension of stores makes use of two eyelet-type lugs that are engaged by hooks in the pylon or rack. The resulting installation has the appearance of two solid cylindrical connections of approximately 2 in. in diameter from store to pylon or rack. Between the lugs, store, and pylon or rack, there is open clearance rather than solid material (as is usually the case in wind tunnel installations). Better physical simulation of the open configuration would mean using an internal balance-supporting bracket with an open passage in the blade that protrudes from the store model, and through which crossflow could occur as the flow field develops in the wind tunnel. With different crossflow patterns, other characteristics of the flow over the store could change also, such as a different pattern of separation. It was to investigate the existence of such effects that a test was recently conducted in a wind tunnel, the results of which are discussed herein.

2.0 EXPERIMENTAL APPARATUS

2.1 TEST FACILITY

Tests were conducted in the Aerodynamic Wind Tunnel (4T) of the Propulsion Wind Tunnel Facility (PWT), a closed-circuit design in which continuous flow can be maintained at various density settings. Mach number in the free stream can be set at any value from 0.2 to 1.3. Nozzle blocks can be installed to provide discrete Mach numbers of 1.6 and 2.0. Stagnation pressure can be established from 300 to 3,700 psfa. The test section is 4 ft square, 12.5 ft long, and is equipped with perforated walls that can be adjusted by remote control to provide a porosity in the nominal range of from 0- to 10-percent open area. A desired fraction of the flow through the test section can be evacuated through the porous walls into a plenum chamber in which the test section is completely enclosed.

Models are supported in the test section with a conventional strut-sting system. A model can be pitched from approximately -12 to 28 deg with respect to the centerline of the tunnel. A capability of rolling a model from -180 to 180 deg about the centerline of the sting is also available. An illustration of a typical model installed for testing is presented in Fig. 2.

2.2 MODELS

2.2.1 Aircraft

Because of the availability of models from the tests described in Refs. 1 and 2, the F-4C was selected as parent aircraft. An outline drawing of the F-4C model is presented in Fig. 3. Throughout the tests, the tail surfaces of the F-4C model were removed. Airflow was allowed through the simulated engine ducts, with cruise-configuration exhaust ports installed Testing was confined to the left wing inboard (LIB) pylon. Left wing outboar and centerline pylons were installed, but no store models were attached. Details of the pylons are shown in Fig. 4.

2.2.2 Stores

In the tests described in Refs. 1 and 2, both pylon-mounted and rack-mounted store configurations were included. Captive loads were measured with both categories of stores supported from the pylon (or rack) with appropriate brackets (see Section 2.2.3). However, the internal balance-supporting brackets used with the pylon-mounted stores were larger, protruded well into the flow, and represented a more substantial departure from the actual configuration of the store on the pylon than the brackets used with the rack-mounted configurations. Hence, only pylon-mounted stores were considered in the study of the effects of bracket design. Two store configurations were included: the Hard-Structure Munition (HSM), a stable store with canards, and the BLU-1 bomb, a clean, unstable shape. Characteristic dimensions of the store models are presented in Fig. 5.

2.2.3 Internal Balance-Supporting Brackets

A typical bracket-supported installation is illustrated in Fig. 6. The store model is securely fastened to one end of a six-component strain-gage balance. The other end of the balance is firmly supported through the use of a rigid bracket protruding through the upper surface of the model and attached to the pylon. To allow unrestricted reaction of the store model (and hence the balance) to aerodynamic loading, the opening in the upper surface of the store model was made large enough to ensure a clearance of at least 0.050 in. around the bracket. The base of each store model was solid, to prevent flow through the interior of the model and past the balance.

Separation between the upper surface of a store model and the lower surface of the pylon was set at 0.125 in., corresponding to a nominal gap maintained between store and aircraft models during dual-support tests, as described in Section 1.0 above. The 0.125-in. gap corresponds to 2.5 in. full size, about twice a typical value, but large enough to reveal the effect of the presence of a solid internal balance-support bracket in the wind tunnel. In addition to providing physical support for the store, the bracket also provided a channel through which the balance wires passed from the store into the aircraft and thence to appropriate signal processing equipment. Photographs of the pylon, bracket, balance, and store components for both the HSM and the BLU-1 are presented in Fig. 7. The solid web from balance socket to pylon is readily apparent in Figs. 7a and b.

To evaluate the effect of the solid bracket, a "ventilated" design concept for the bracket web was conceived and fabricated. A slot was cut through the web of the bracket, tangent to both the upper surface of the store model and the lower surface of the pylon (see Figs. 7c and d). The remaining bracket material simulated actual lug suspension. Photographs of the solid and "ventilated" bracket installations for the two store configurations tested are presented in Fig. 8.

2.3 INSTRUMENTATION

Conventional strain-gage balances were used to sense the aerodynamic forces acting on the store models. Six components of forces and moments were resolved, as described in Section 3.3. The gravimetric angle of attack of the F-4C aircraft model was sensed with an oil-damped pendulum fitted with strain gages and mounted in the aircraft model instead of using the purely mechanical indication associated with the conventional tunnel pitch sector.

3.0 DESCRIPTION OF TESTS

3.1 FLOW CONDITIONS AND TEST PROCEDURES

Aerodynamic forces and moments acting on the store models were measured at nominal free-stream Mach numbers of 0.6, 0.8, 0.9, 1.1, and 1.2. Reynolds number was maintained at approximately 3.5×10^6 per foot throughout the test:

Porosity of the test section walls was varied in a manner determined through previous calibration studies in the tunnel (Refs. 3 and 4).

During the tests, flow conditions were established before the attitude of the model was set. A pitch-pause technique was used, in which the aircraft model attitude was set and maintained for approximately three seconds at each value of a specified sequence of attitudes. Data were recorded at the end of a pause, after which the attitude was changed to the next sequential value. After completing a sequence of attitudes at a fixed Mach number, flow conditions were changed to establish the next specified Mach number, and the pitch-pause sequence was repeated.

3.2 CORRECTIONS

As discussed in Section 2.3, the attitude of the aircraft model was set using a gravity-sensing device mounted in the model. Therefore, no correction was necessary for deflections of the aircraft model with respect to the sting, or for deflections of the sting with respect to the pitching sector. For the balance used inside the store models, calibrations of the deflections of the mounting point of the store as a function of impressed load were used to identify contributions of balance flexibility to the attitude of the store model. The calibration data were used in the data reduction equations to derive the correct gravimetric attitude of the store model. (It is appropriate to recall here that both store models were supported with the longitudinal axis parallel to the lower surface of the pylon, i.e., with a 1-deg nose-down attitude with respect to the waterline of the aircraft model, see Fig. 4.) No corrections were made in either aircraft or store model attitude to account for flow angularity in the free stream.

3.3 PRECISION OF MEASUREMENTS

Uncertainty intervals (including 95 percent of the calibration data) for the basic flow parameters, i.e., p_{t_∞} and M_∞ were estimated from both repeated calibrations of the instrumentation and the repeatability and uniformity of the free-stream flow in the test section during tunnel calibration. Uncertainty intervals for the instrumentation systems were estimated from repeated calibrations of the systems using secondary standards with accuracies traceable to the National Bureau of Standards. Uncertainty intervals for values of forces and moments derived from the output of the balance gages were determined from a root-mean-square analysis of the calibration data from the balance. Values of the above uncertainties were combined using the Taylor series method of error propagation to determine the precision of the force and moment coefficients. Values of the uncertainty intervals for the force and moment coefficients for the models tested are presented below:

	M_∞				
	0.6	0.8	0.9	1.1	1.2
C_N	±0.047	±0.036	±0.034	±0.030	±0.030
C_Y	±0.070	±0.054	±0.052	±0.045	±0.044
C_A	±0.012	±0.008	±0.008	±0.008	±0.008
C_ℓ	±0.024	±0.018	±0.018	±0.016	±0.015
C_m	±0.108	±0.084	±0.080	±0.071	±0.068
C_n	±0.086	±0.067	±0.064	±0.058	±0.054

For all flow conditions, the uncertainty interval for gravimetric angle of attack was ±0.1 deg. However, two uncertainty intervals must be cited for Mach number. First, the uncertainty in setting Mach uumber was ±0.002, reflecting instrumentation capabilities. Second, there was the uncertainty in Mach number in the free stream, attributable to nonuniform flow effects such as angularity. A table of values of the uncertainty interval for Mach number is presented below:

Nominal M_∞	Uncertainty in M_∞
0.6	±0.005
0.8	±0.005
0.5	±0.003
1.1	±0.006
1.2	±0.010

4.0 DISCUSSION OF RESULTS

4.1 STABLE STORE CONFIGURATION

In Figs. 9 through 14, the effects of using a ventilated supporting bracket are presented for the aerodynamic forces and moments acting on the Hard Structure Munition (HSM) configuration. In the (a) portion of each figure, the aerodynamic loads acting on the store model using solid- and ventilated-supporting brackets are presented as a function of the gravimetric angle of attack of the store. In the (b) portion of the figures, the effects of using the ventilated bracket are presented in incremental form, i.e., the difference between the values of the load components obtained supporting the store with the ventilated bracket and the values obtained supporting the store with the solid bracket.

For the range of $-4 \leqq \alpha_s \leqq 4$ deg, an almost constant decrease in normal-force coefficient of approximately 0.07 is evident at all Mach numbers (Fig. 9). For attitudes greater than 4 deg, solid bracket data and ventilated bracket data are in better agreement. Since the slope of the normal-force curve is more uniform when using the ventilated bracket, it is plausible that the effect of the bracket is to delay separation of the flow from the upper surface with respect to store attitude. However, over the same range of store attitude, pitching moment (Fig. 10) does not always vary in a manner expected of a stable store. For example, at $\alpha_s = 4$ deg, $M_\infty = 0.6$, virtually no change in pitching moment is evident

(Fig. 10b) in spite of a change in normal force of -0.03 (Fig. 9b); or at α_s = 6 deg, M_∞ = 1.1, in spite of no change in normal force, an effect on pitching moment of -0.17 is recorded. It is clear that the location of the center of pressure must change with use of the ventilated bracket.

Additional evidence supporting the hypothesis of an altered pressure distribution is available from the data associated with the lateral degree of freedom. Side force is virtually unaffected by the bracket (Fig. 11), but yawing moment is affected (Fig. 12). Rolling moment is generally decreased at the higher angles of attack with use of the ventilated bracket (Fig. 13), indicating a reduced lateral displacement of the flow over the upper portion of the afterbody and over the fins. In the range $-4 \leqq \alpha_s \leqq 4$ deg, axial force is unaffected by use of the ventilated bracket, but for store attitudes greater than 4 deg, sensible effects are noted (Fig. 14). Since the bracket is not an active surface with respect to the balance, the decrease in axial force that accompanies use of the ventilated bracket must again be attributable to a change in pressure distribution. The source of the changed distribution appears to be either delayed separation or an altered crossflow pattern.

4.2 UNSTABLE STORE CONFIGURATION

Data obtained for the unstable BLU-1 store configuration are presented in the same manner as for the HSM in Figs. 15 through 20. In Fig. 15, a totally different effect of the bracket design on the coefficient of normal force acting on the store is evident as compared with the HSM. Not only is the effect of the opposite sign in the low range of store attitude (normal force increasing with use of the ventilated bracket rather than decreasing, as in the case of the HSM), but also the effect tends to increase rather than decrease at the higher store attitudes. The effect on pitching moment is also different from that for the stable store (Figs. 16 and 10), almost negligible overall, and generally decreasing at the higher store attitudes. A shift in the center of pressure appears to occur for the unstable configuration, but it is within the range of the uncertainty of the measurements.

Virtually no effect of the ventilated bracket design is evident for either side force or yawing moment (Figs. 17 and 18). Rolling moment is totally negligible for the unstable store, and no bracket effect is perceptible (Fig. 19). The same slight negative on axial-force coefficient is observed as for the stable configuration (Fig. 20). As an explanation for the decrease in axial force, an altered pressure distribution when using the ventilated bracket can be hypothesized, just as for the stable store configuration.

5.0 CONCLUDING REMARKS

When supporting a store model in the captive position in wind tunnel tests, use of a ventilated internal-support bracket apparently results in a different pressure distribution over the store model from that existing with a solid bracket, especially in the aft region. For example, of the six conventional body-axis force-and-moment components, normal force and pitching moment acting on both stable and unstable store configurations in the range $0.6 \leq M_\infty \leq 1.2$ are most sensibly affected when a ventilated bracket is used. Axial force is consistently decreased for store attitudes in excess of approximately 4 deg. For the stable configuration tested, rolling moment and yawing moment are also sensibly affected by use of the ventilated bracket. For store attitudes in excess of approximately 4 deg, the decreased rolling moment and the increased yawing moment with the ventilated bracket indicate differences in the effectiveness of the fins, attributable to immersion in different crossflow and/or separation flow fields.

Captive and near-captive loads data are fundamental inputs to some computer programs designed to predict store separation trajectories. While the differences in captive loads attributable to use of the ventilated bracket may not be critical with respect to structural design, these same differences can affect analytically predicted trajectories and impact coordinates. To improve prospects of satisfactory prediction of trajectories, it is recommended that internal balance-supporting brackets used in wind tunnel tests to obtain captive store loads be designed to more nearly simulate actual suspension.

REFERENCES

1. Dix, R. E. "Influences of Sting Support on Aerodynamic Loads Acting on Captive Store Models." AEDC-TR-76-1, AFATL-TR-76-25 (ADA022257), March 1976.

2. Dix, R. E. "Comparison of Two Methods Used to Measure Aerodynamic Loads Acting on Captive Store Models in Wind Tunnel Tests." AEDC-TR-76-122.

3. Jacocks, J. L. and Hartley, M. C. "Calibration of the AEDC-PWT 4-Foot Transonic Tunnel with Modified Walls." AEDC-TR-69-134 (AD853841), June 1969.

4. Gunn, J. A. "Calibration of the AEDC-PWT Aerodynamic Wind Tunnel (4T) Using Diffuser Flap Plenum Suction." AEDC-TR-70-74 (AD867975), April 1970.

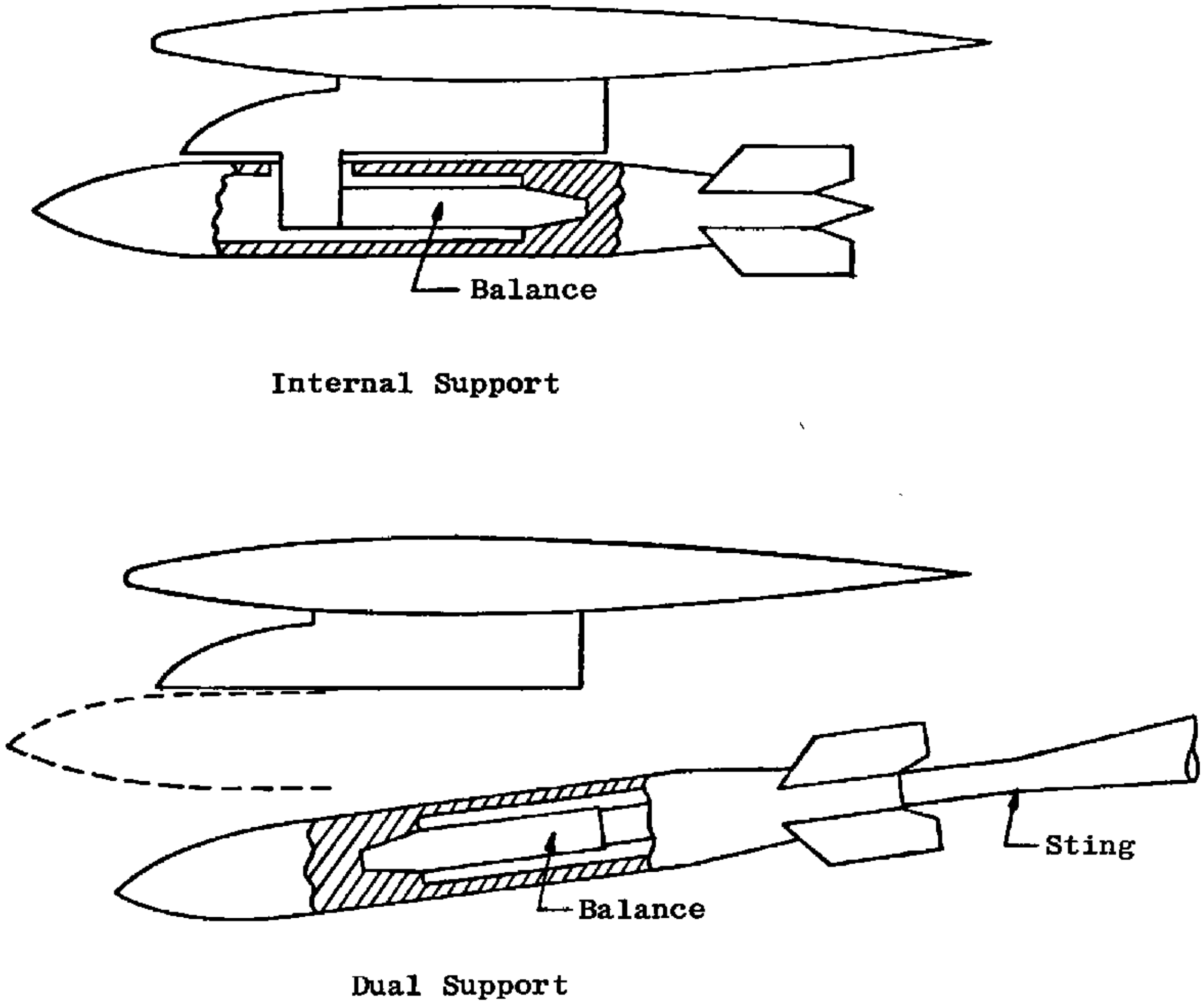


Figure 1. Two methods of supporting a store in the captive position in wind tunnel tests.

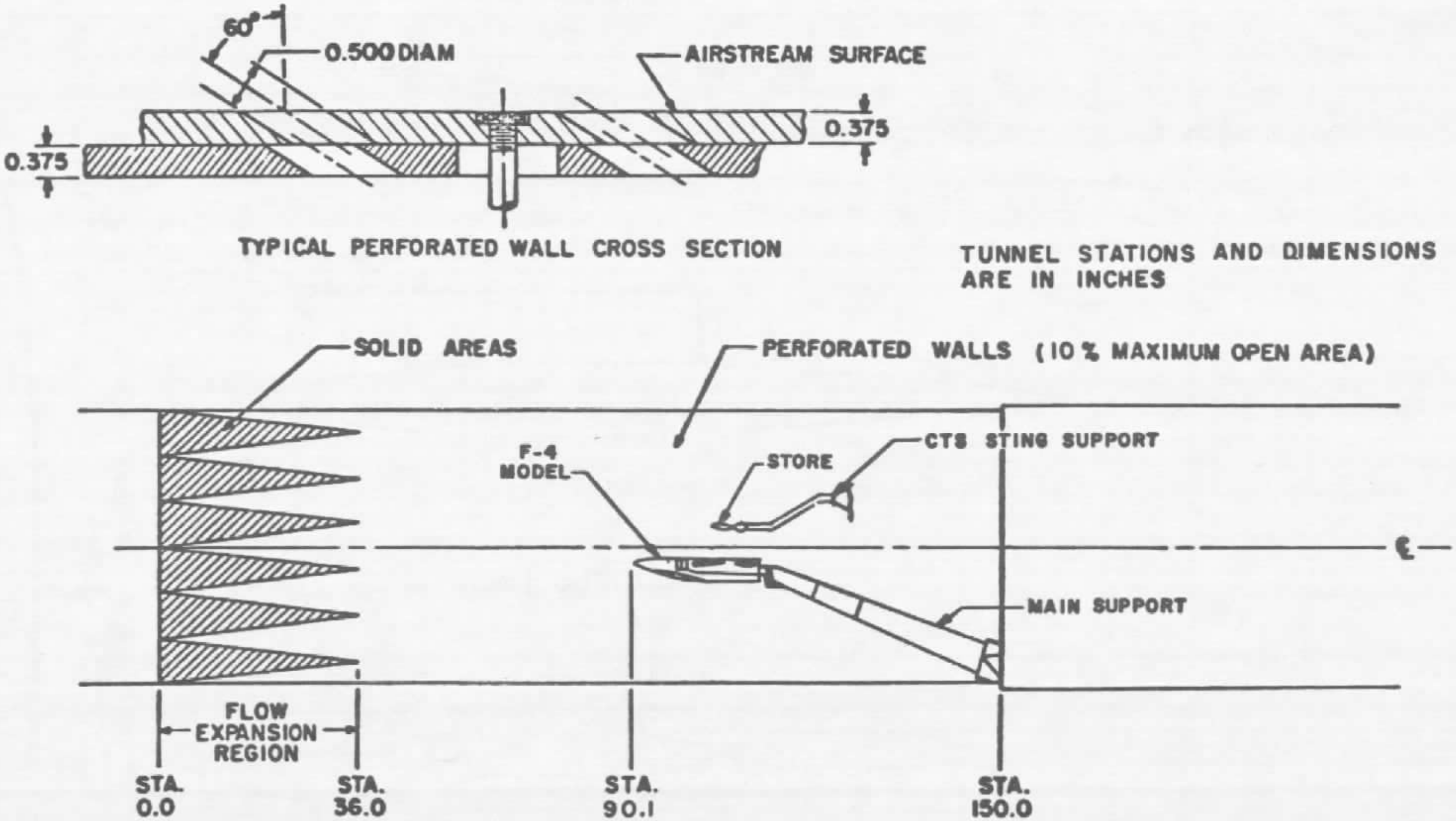


Figure 2. Schematic illustration of a typical model installation in Tunnel 4T.

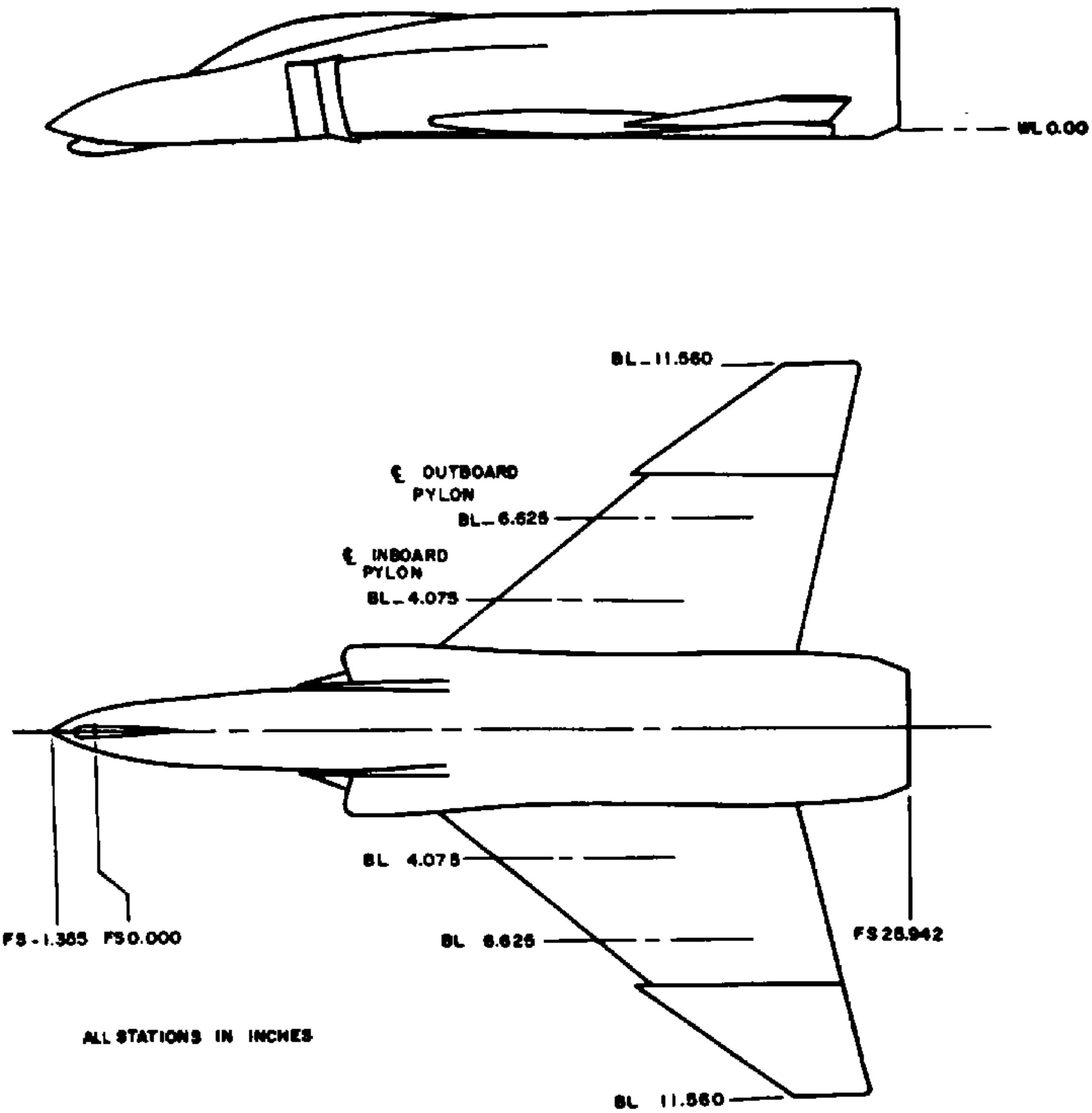


Figure 3. 1/20-Scale model of the F-4C aircraft.

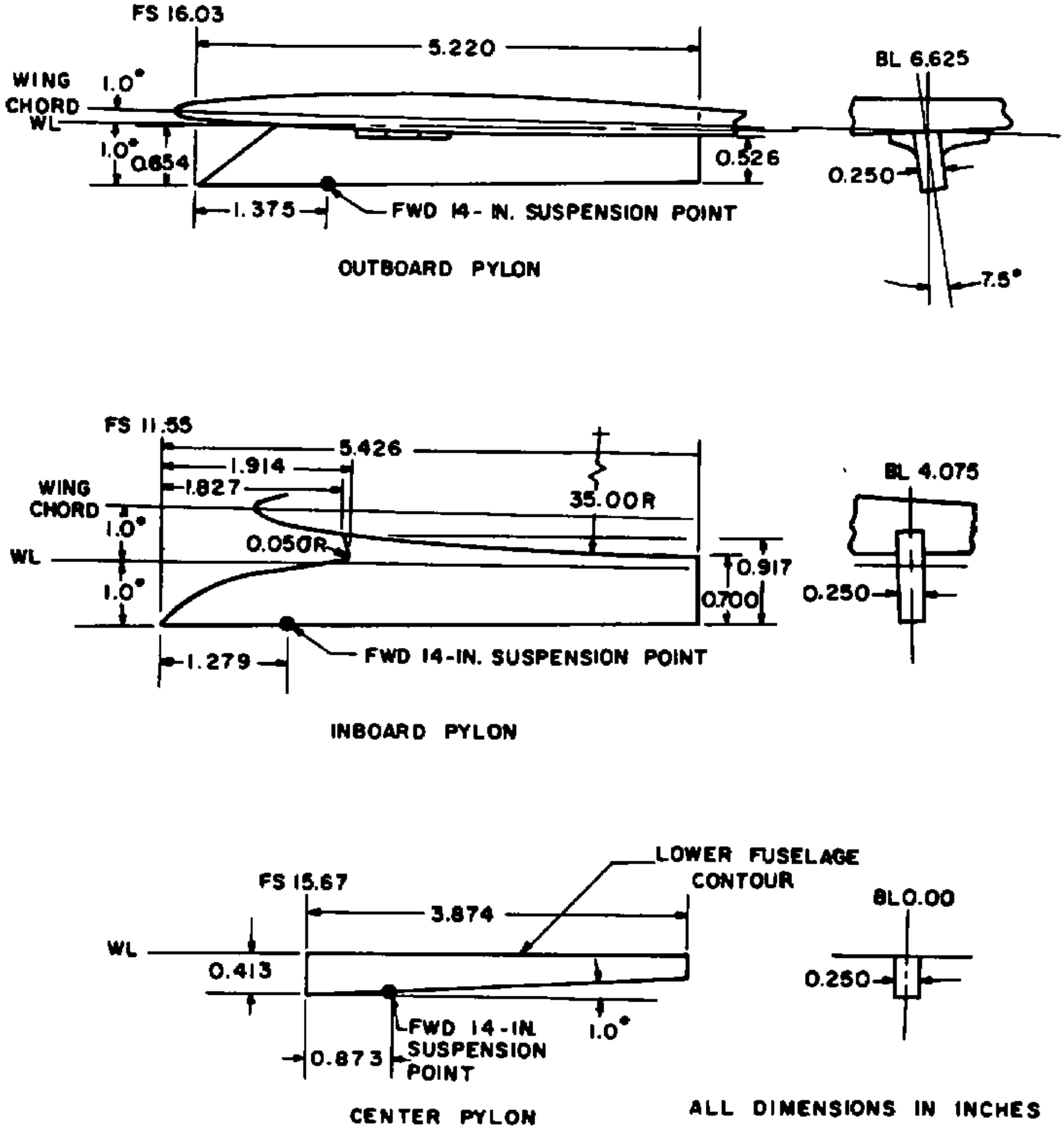
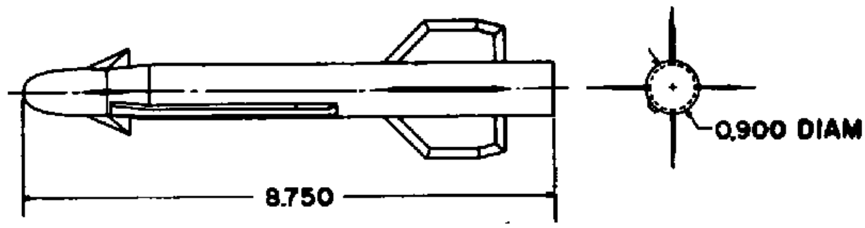
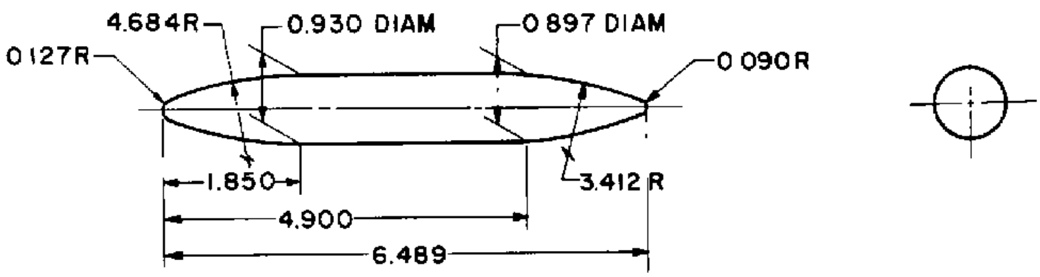


Figure 4. Details of the models of the F-4C pylons.

DIMENSIONS IN INCHES



a. Hard structure munition



b. BLU-1 bomb

Figure 5. Dimensions of the store models.

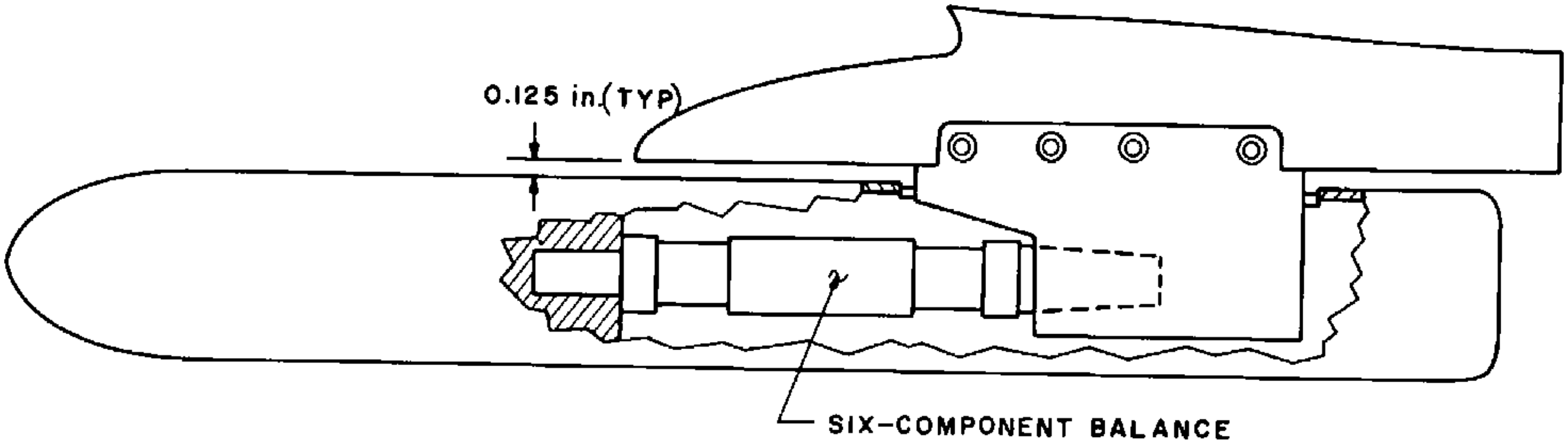
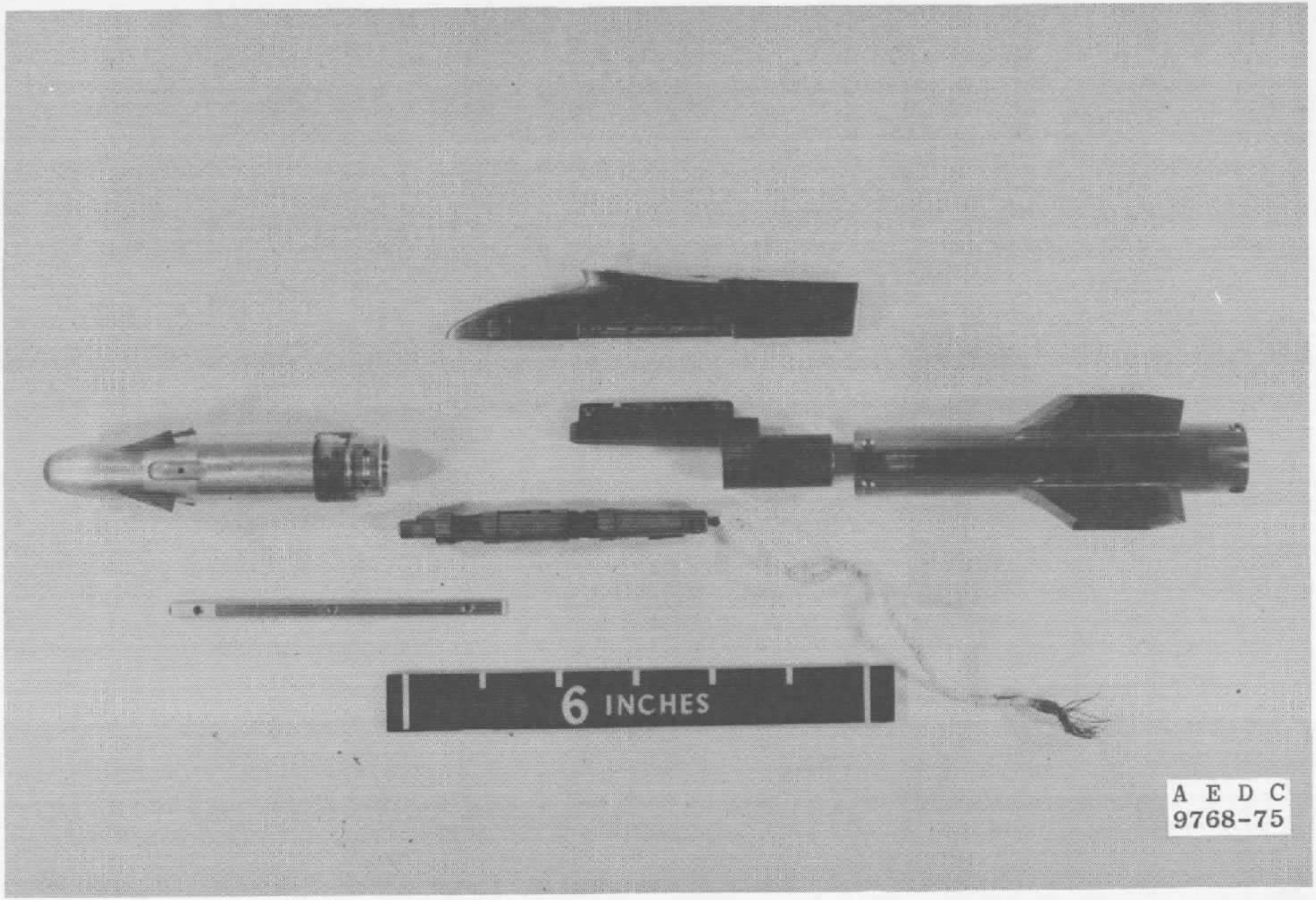
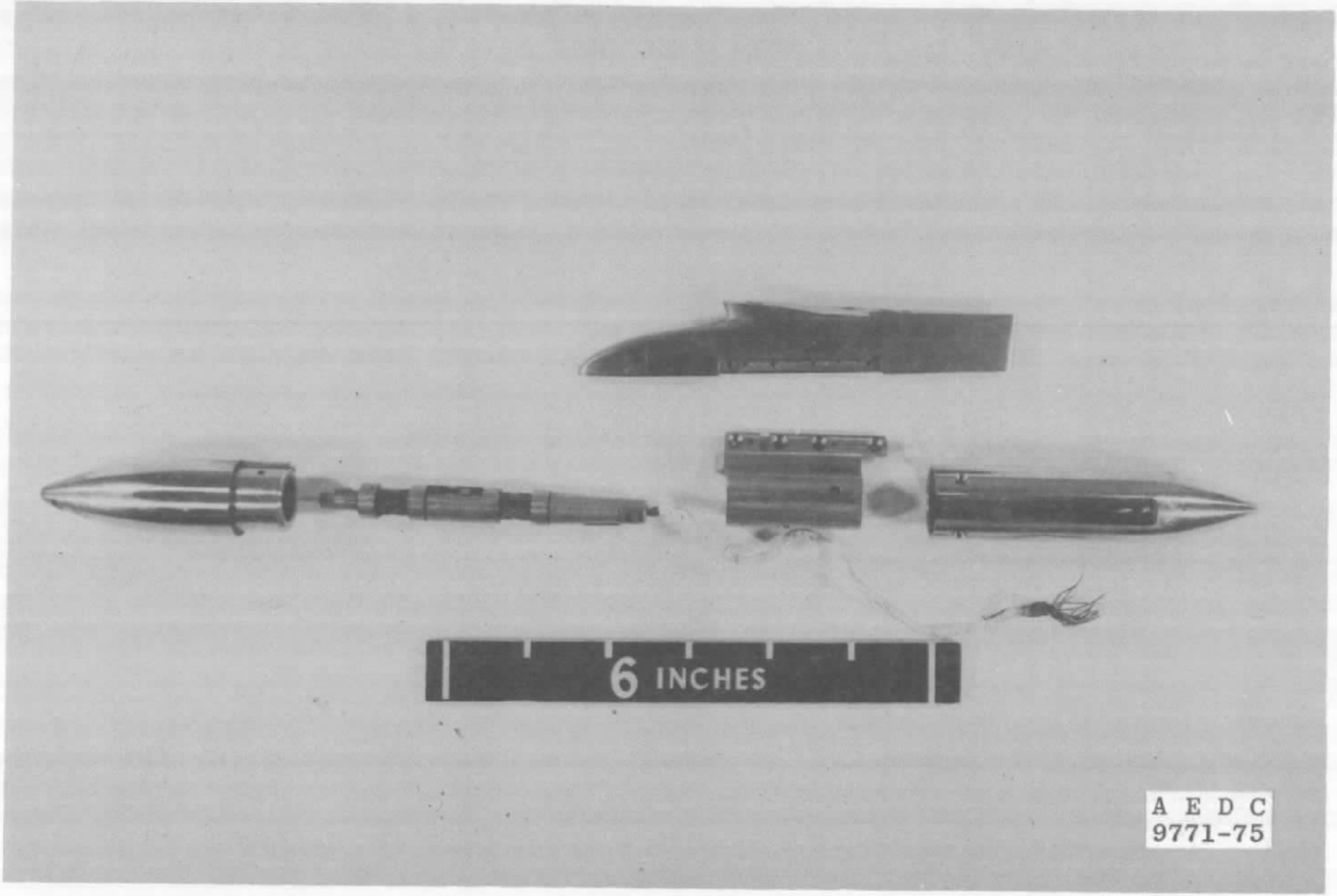


Figure 6. Typical installation of an internal balance-supporting bracket.

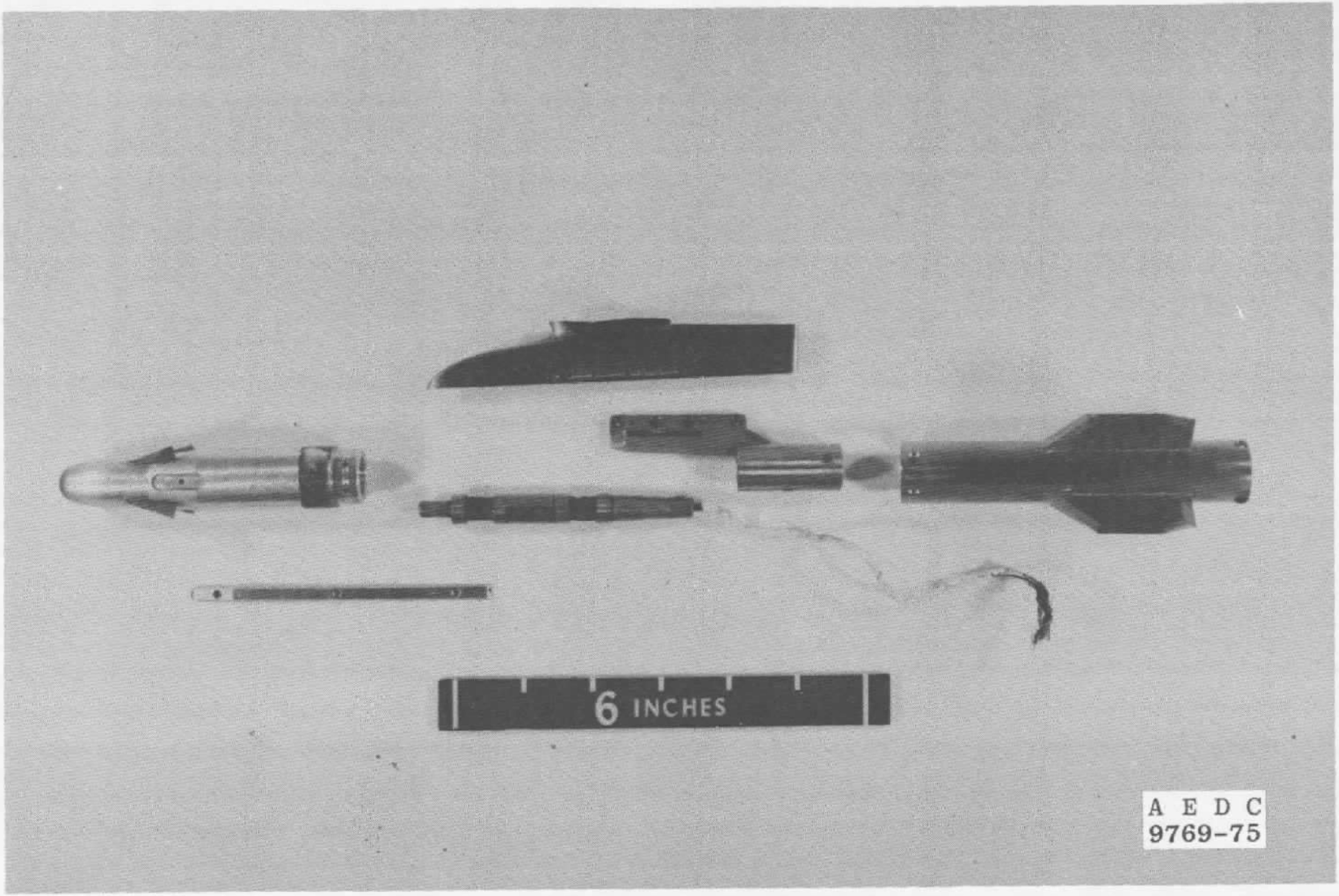


a. HSM, solid bracket

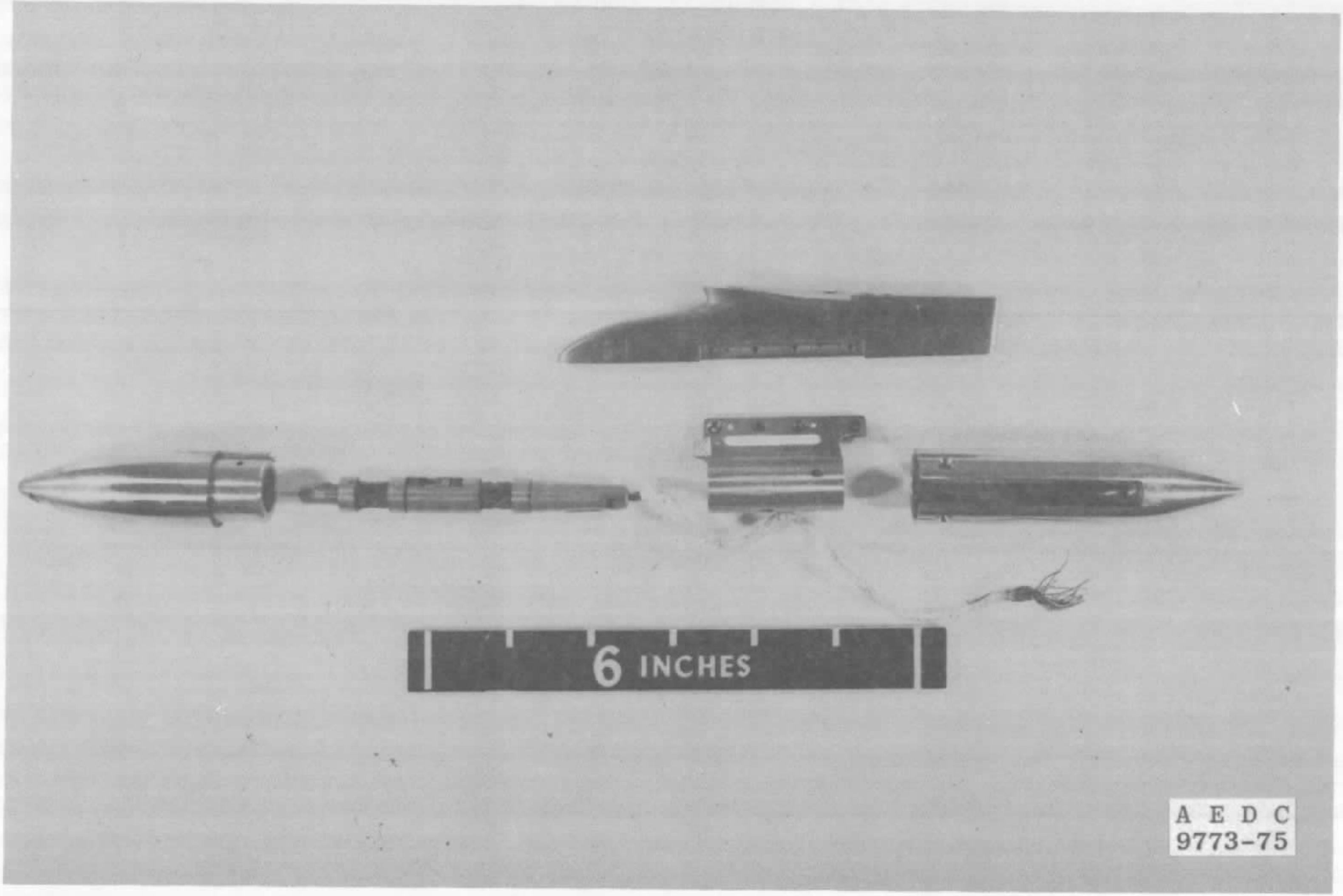
Figure 7. Pylon, bracket, balance, and store model components.



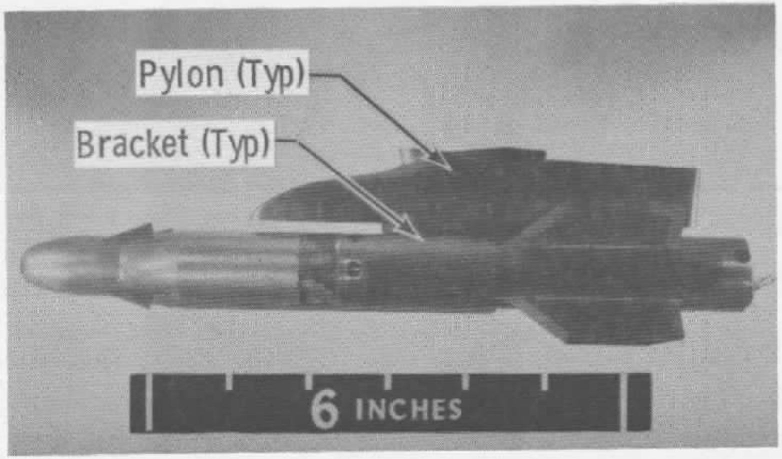
b. BLU-1, solid bracket
Figure 7. Continued.



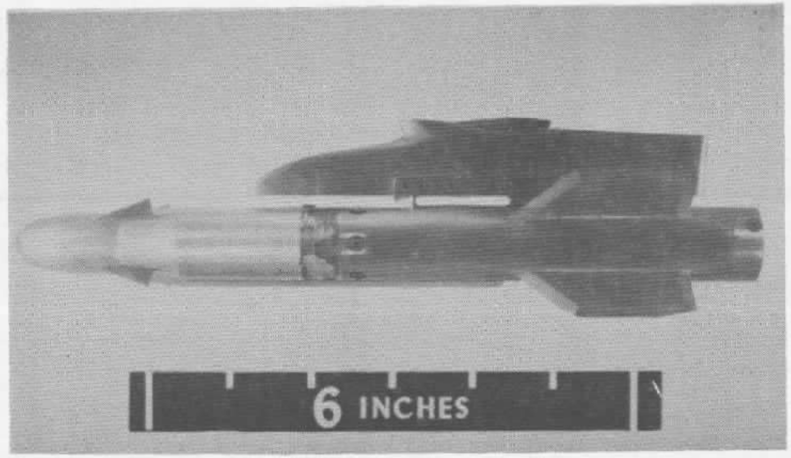
c. HSM, ventilated bracket
Figure 7. Continued.



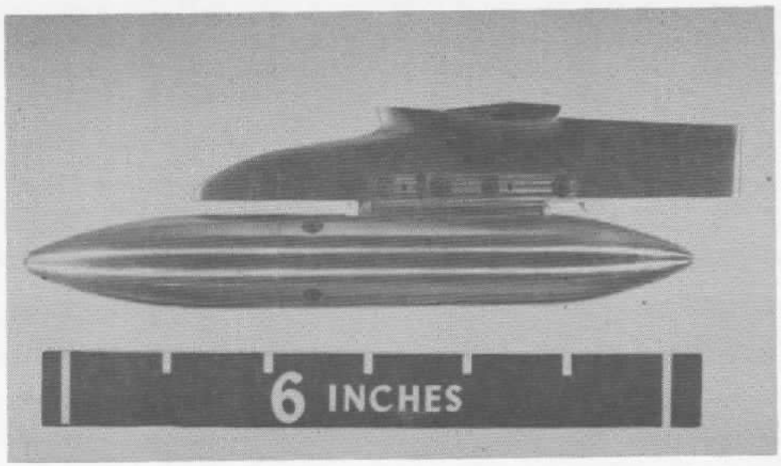
d. BLU-1, ventilated bracket
Figure 7. Concluded.



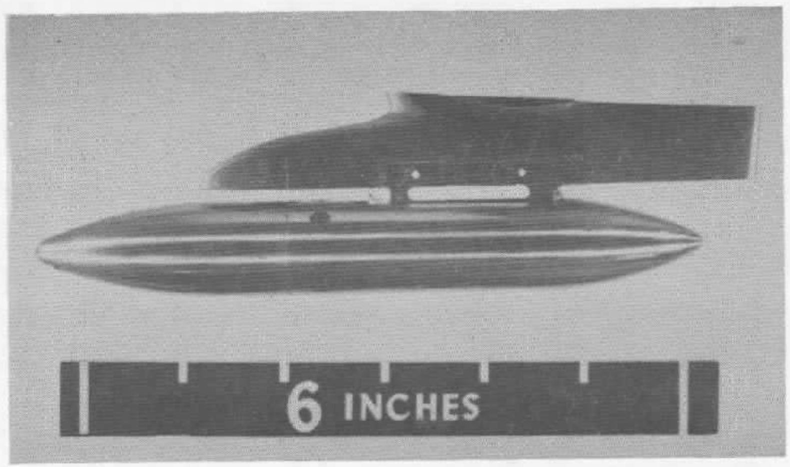
a. HSM, solid bracket



b. HSM, ventilated bracket

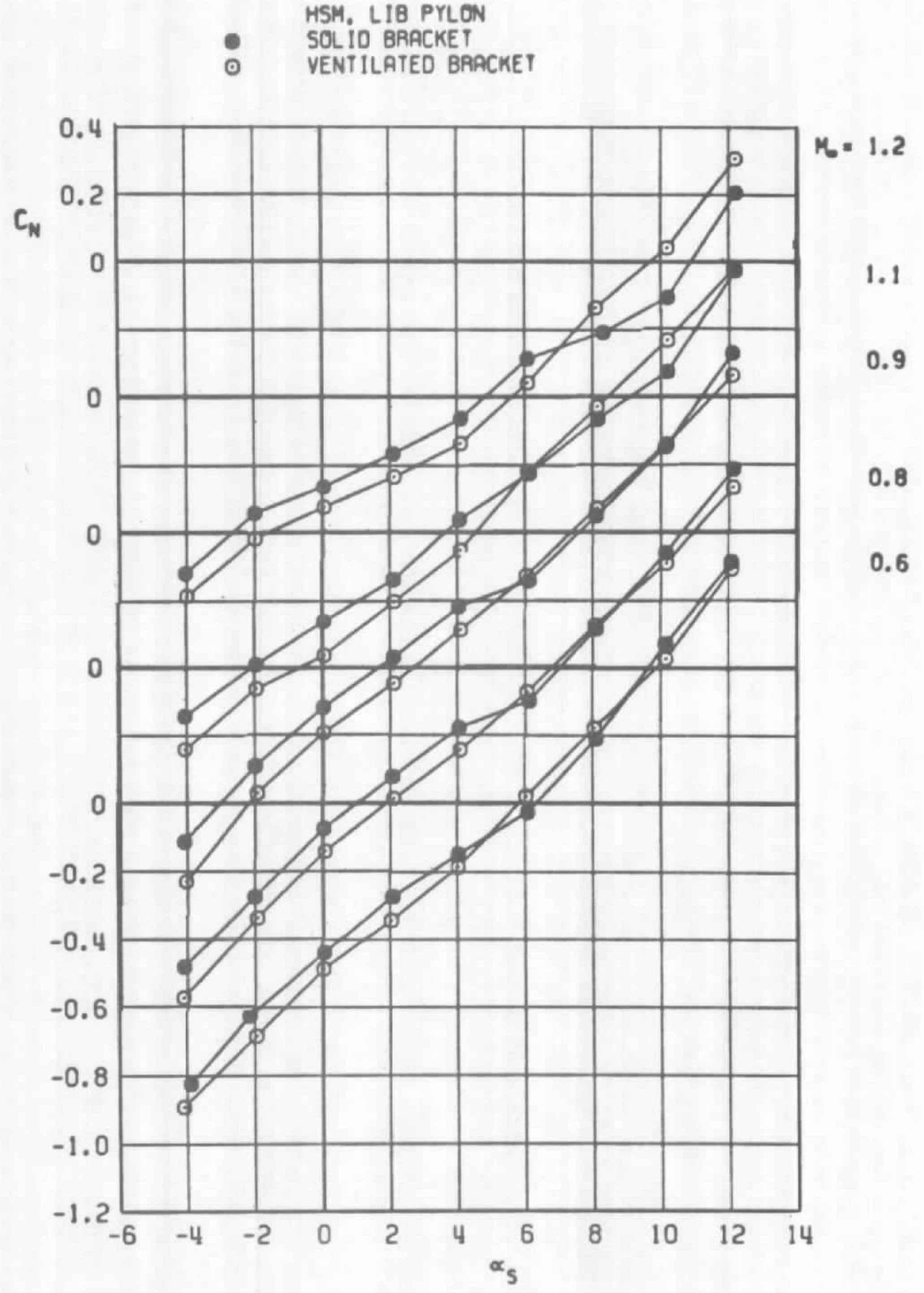


c. BLU-1, solid bracket



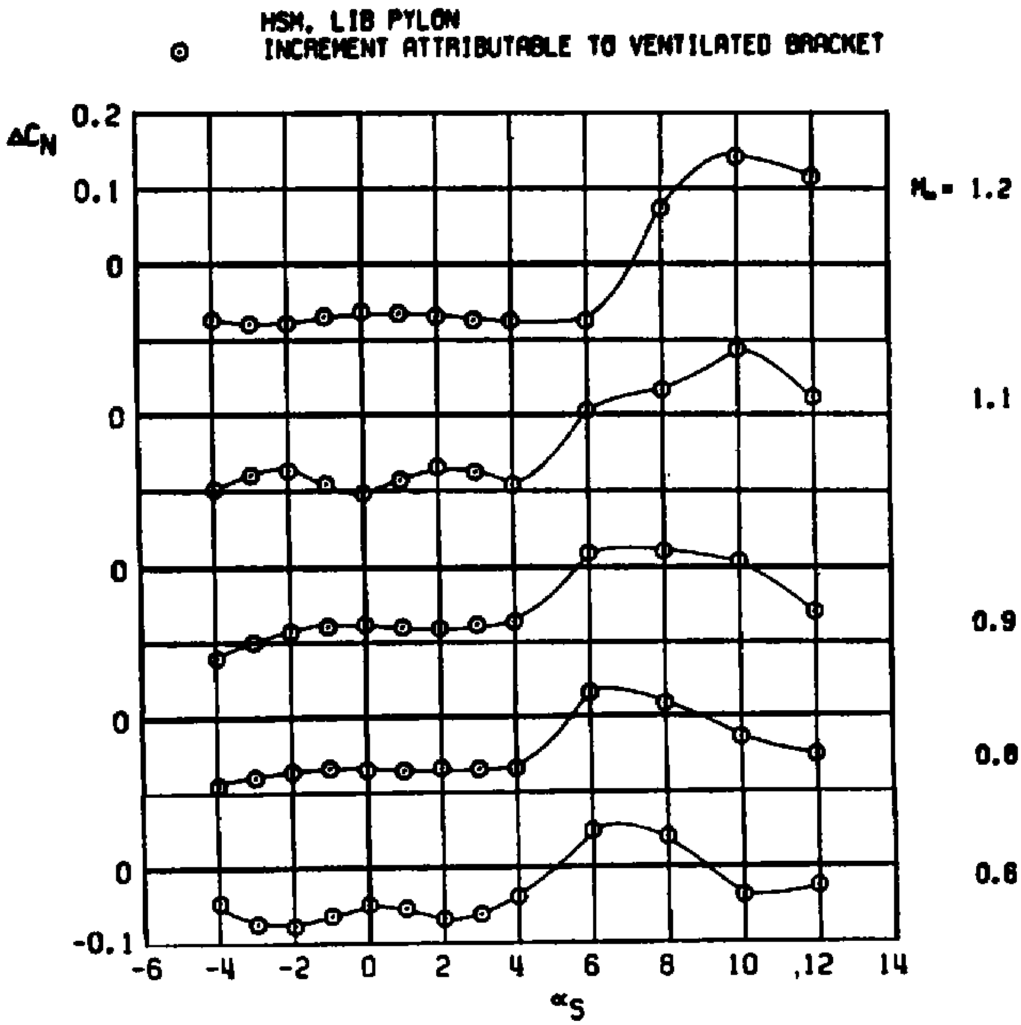
d. BLU-1, ventilated bracket

Figure 8. Comparison of solid and ventilated bracket installations.

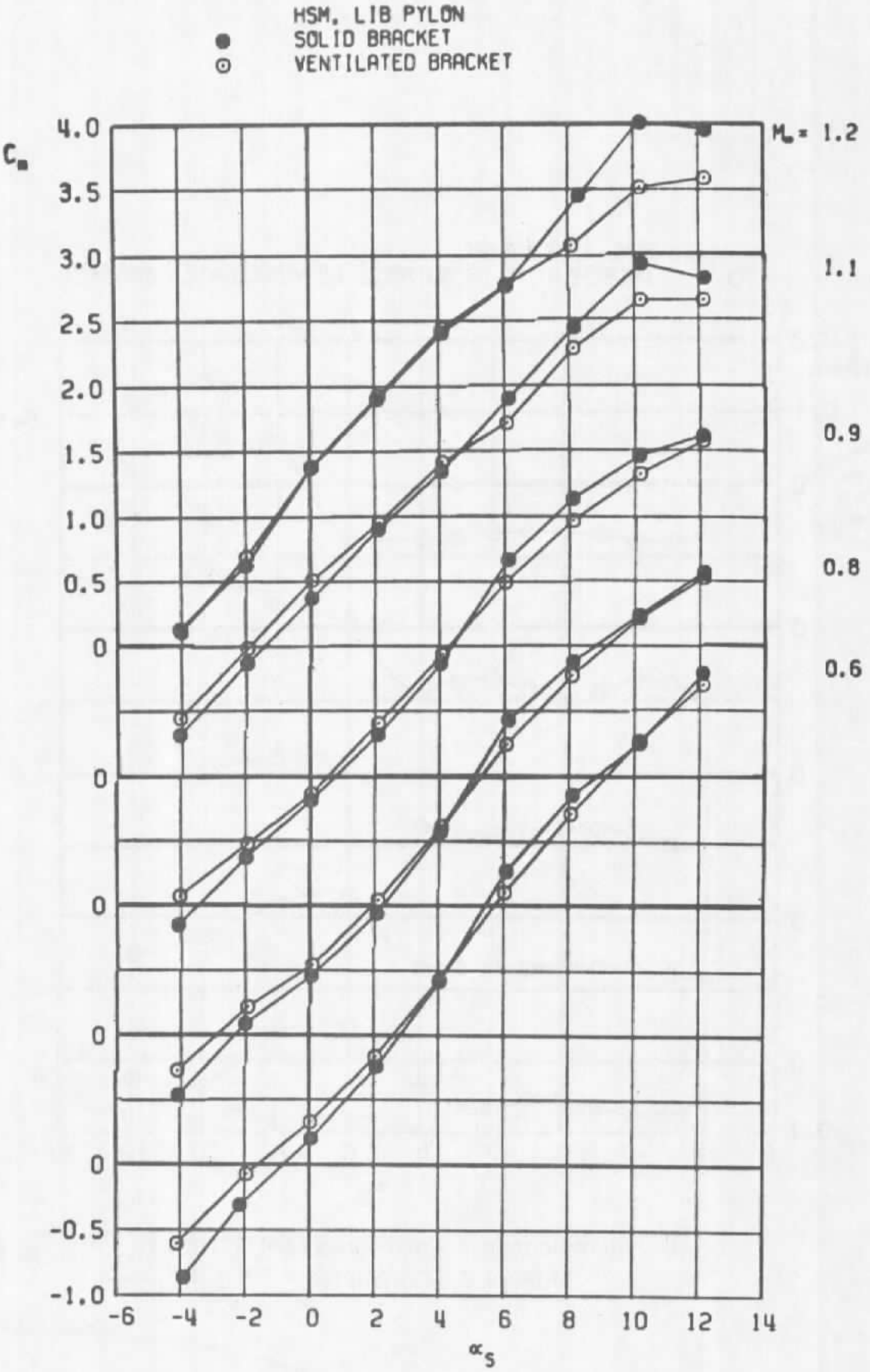


a. Fundamental normal-force coefficient data

Figure 9. Effect on normal-force coefficient of a ventilated bracket supporting the HSM.

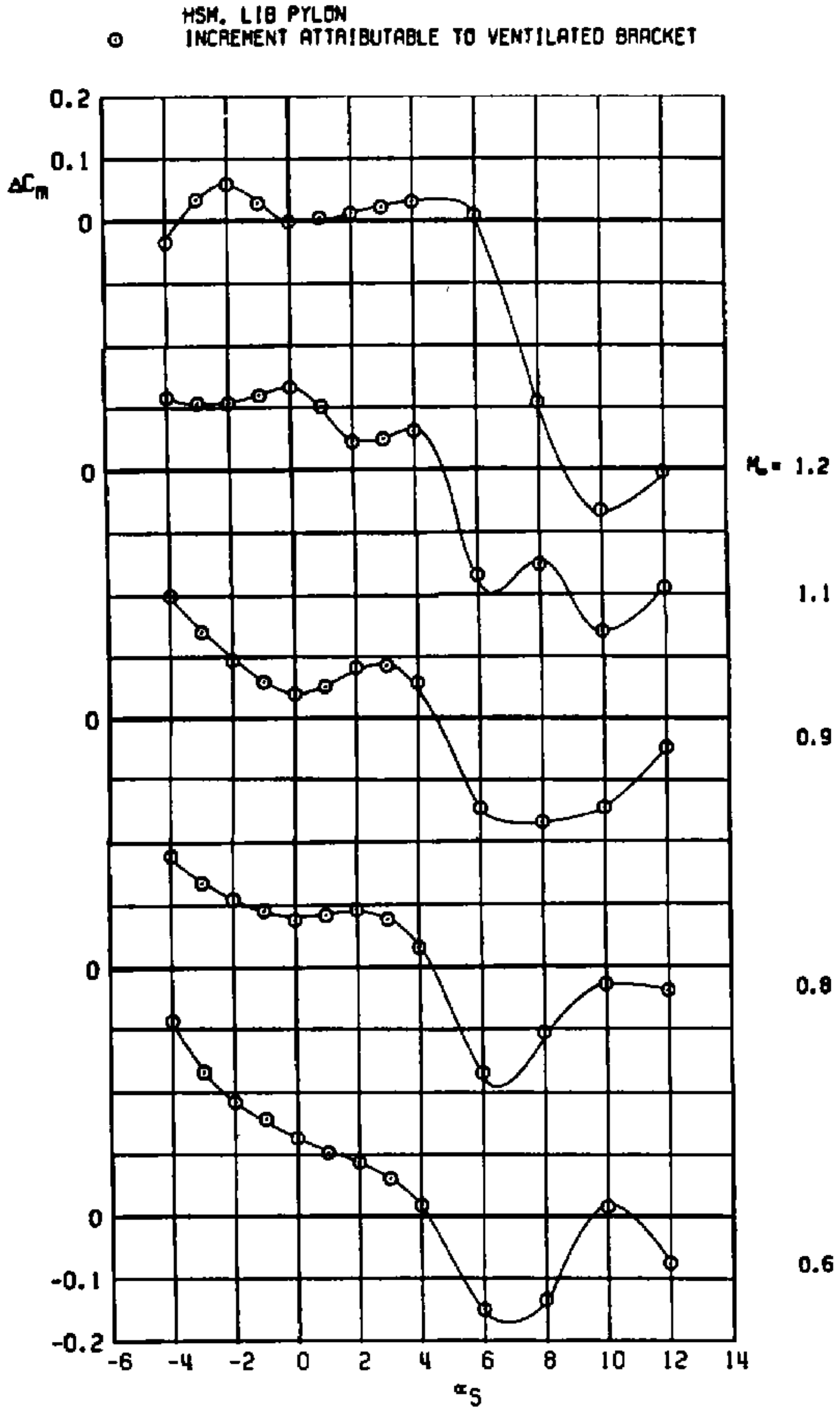


b. Increment in normal-force coefficient
Figure 9. Concluded.

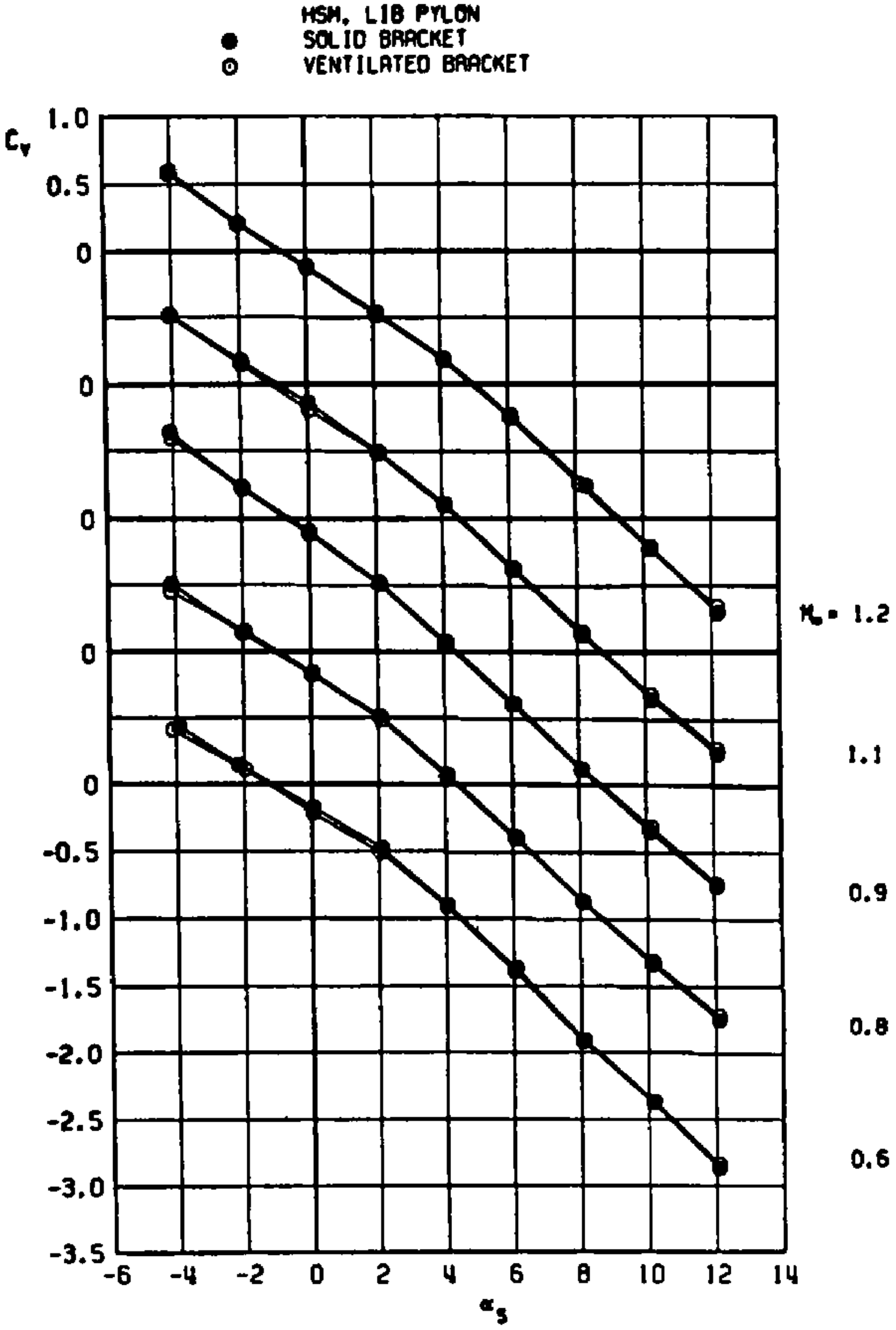


a. Fundamental pitching-moment coefficient data

Figure 10. Effect on pitching-moment coefficient of a ventilated bracket supporting the HSM.

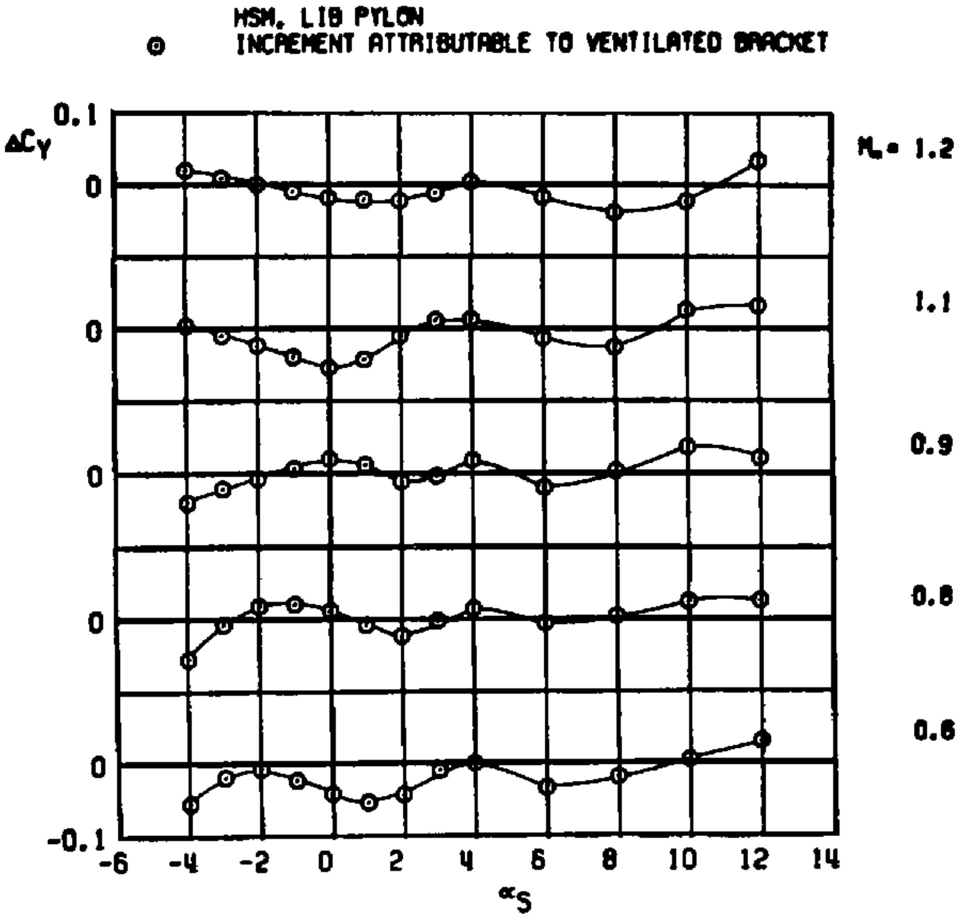


b. Increment in pitching-moment coefficient
Figure 10. Concluded.

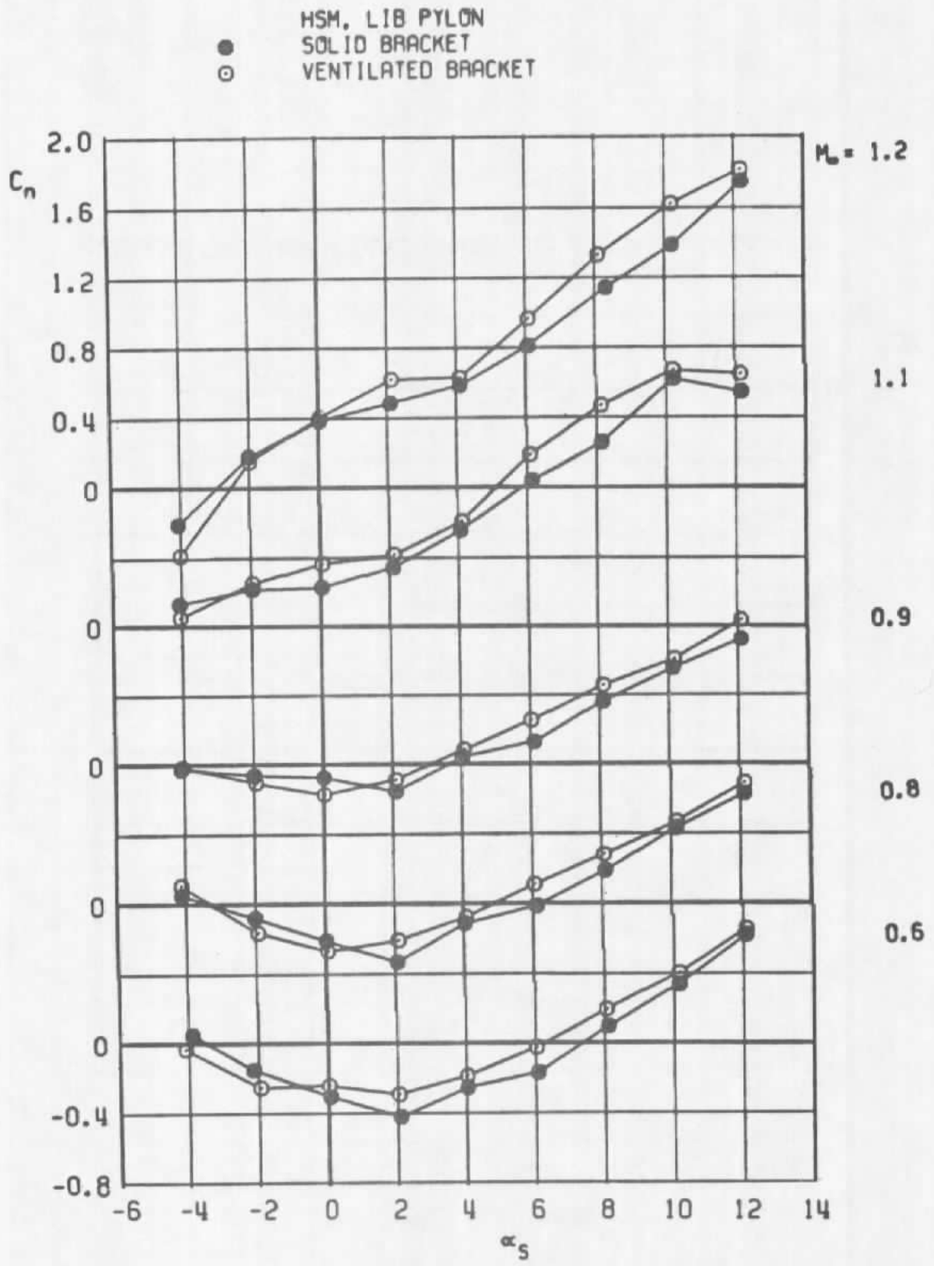


a. Fundamental side-force coefficient data

Figure 11. Effect on side-force coefficient of a ventilated bracket supporting the HSM.

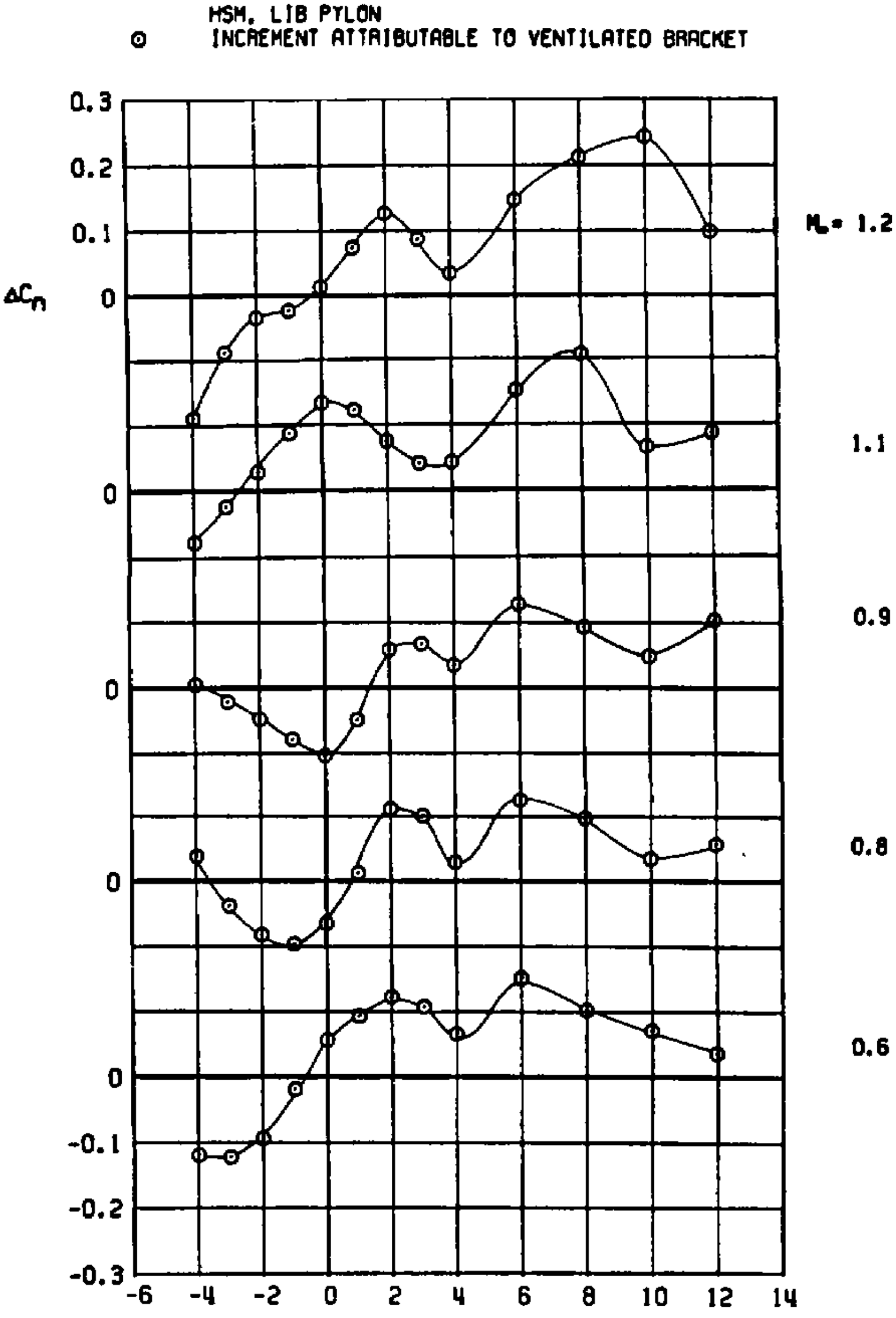


b. Increment in side-force coefficient
Figure 11. Concluded.

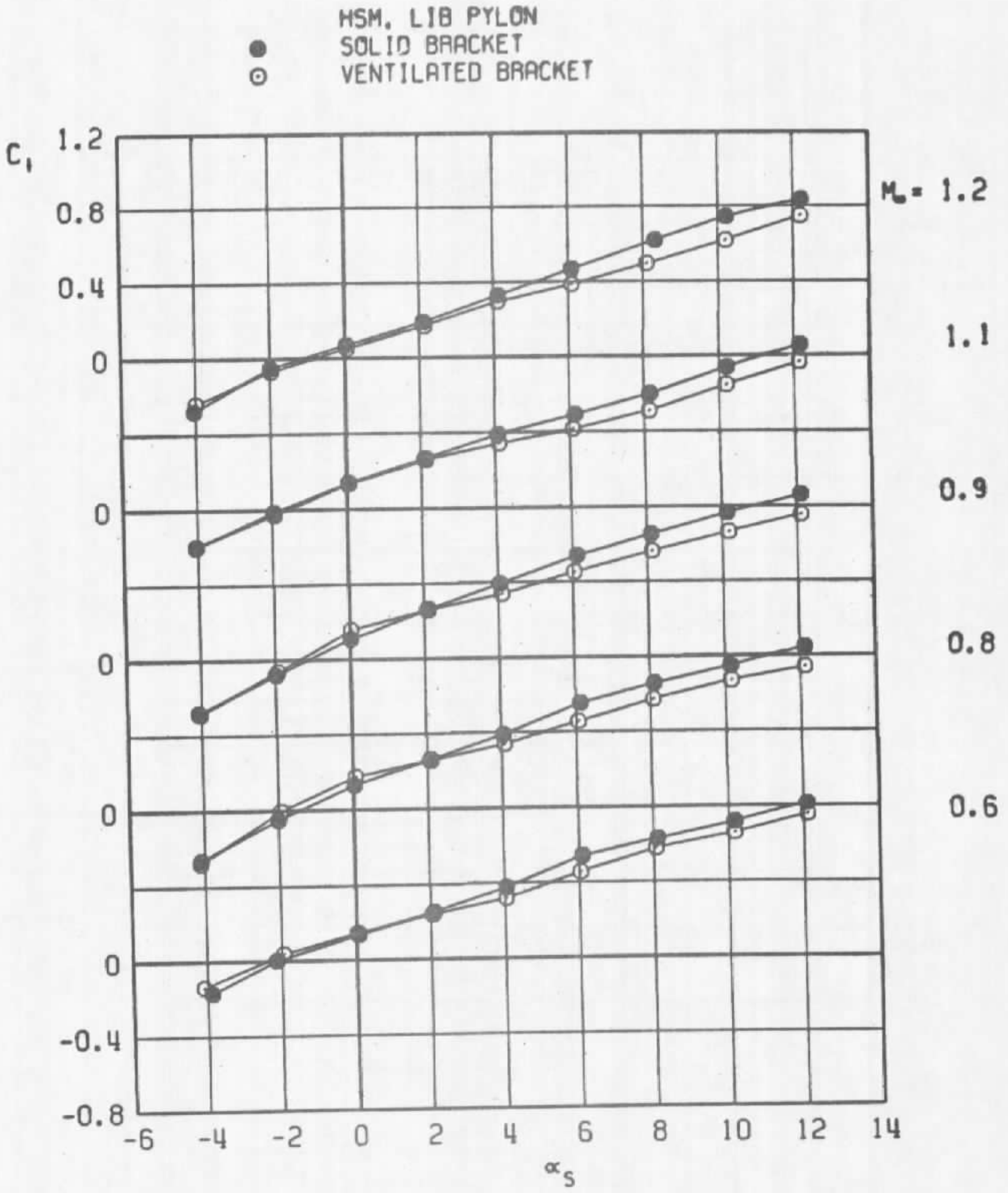


a. Fundamental yawing-moment coefficient data

Figure 12. Effect on yawing-moment coefficient of a ventilated bracket supporting the HSM.

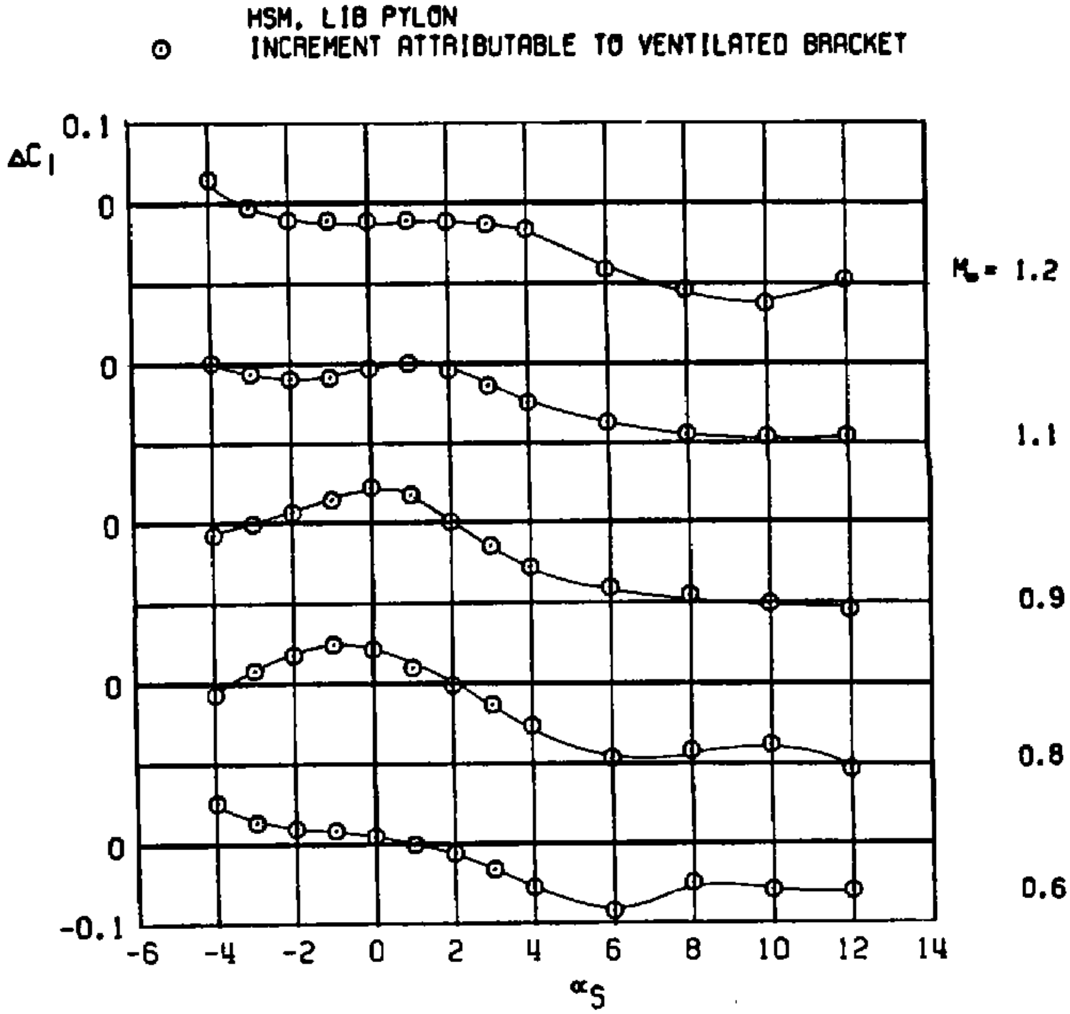


b. Increment in yawing-moment coefficient
Figure 12. Concluded.

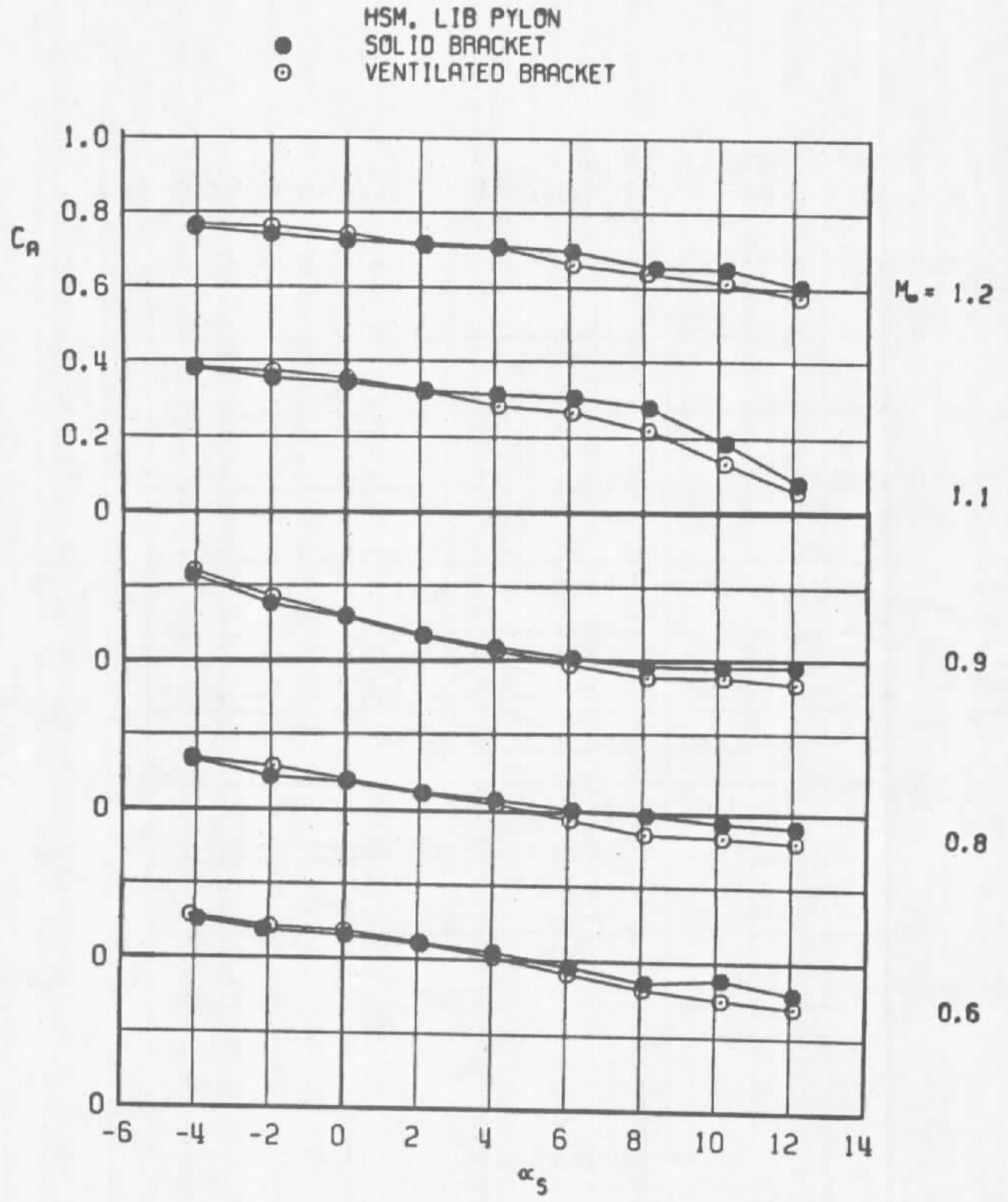


a. Fundamental rolling-moment coefficient data

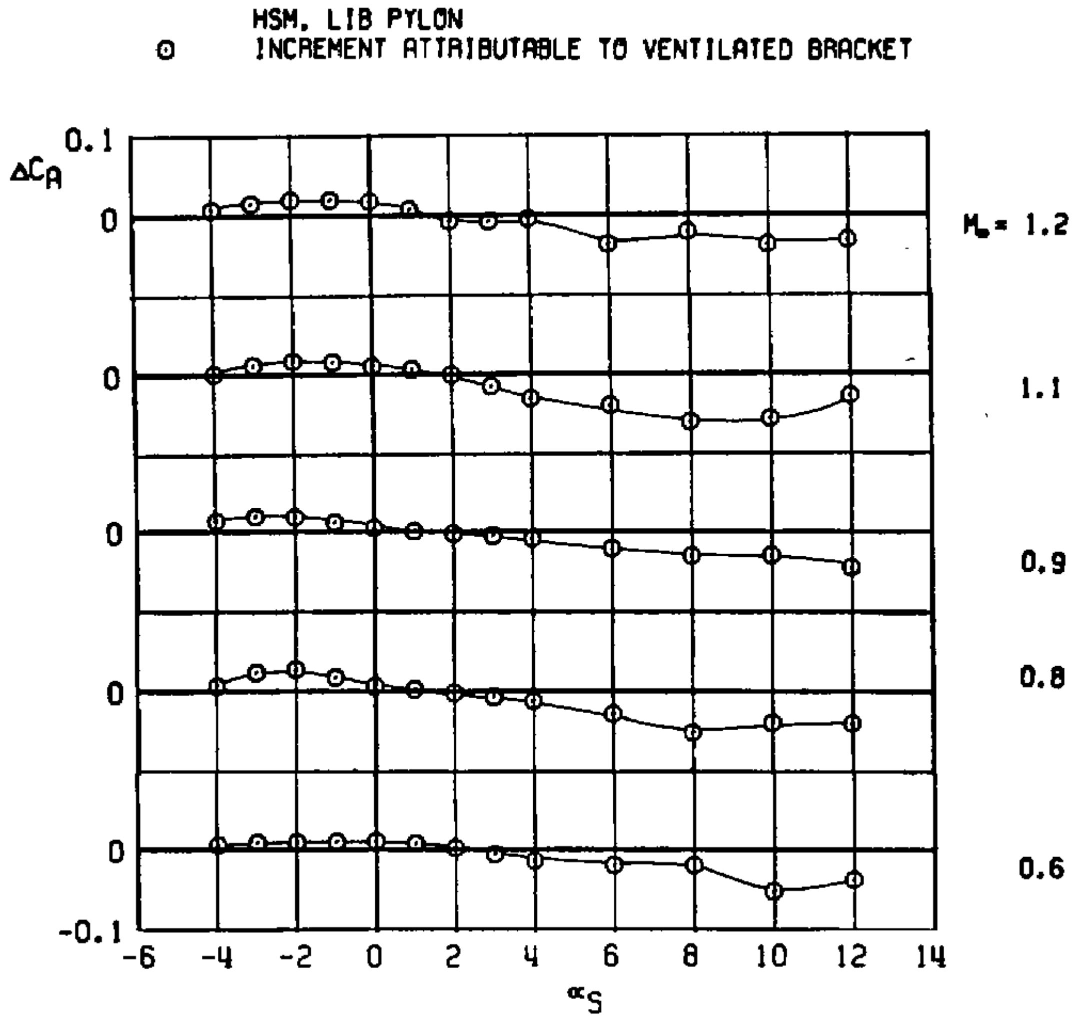
Figure 13. Effect on rolling-moment coefficient of a ventilated bracket supporting the HSM.



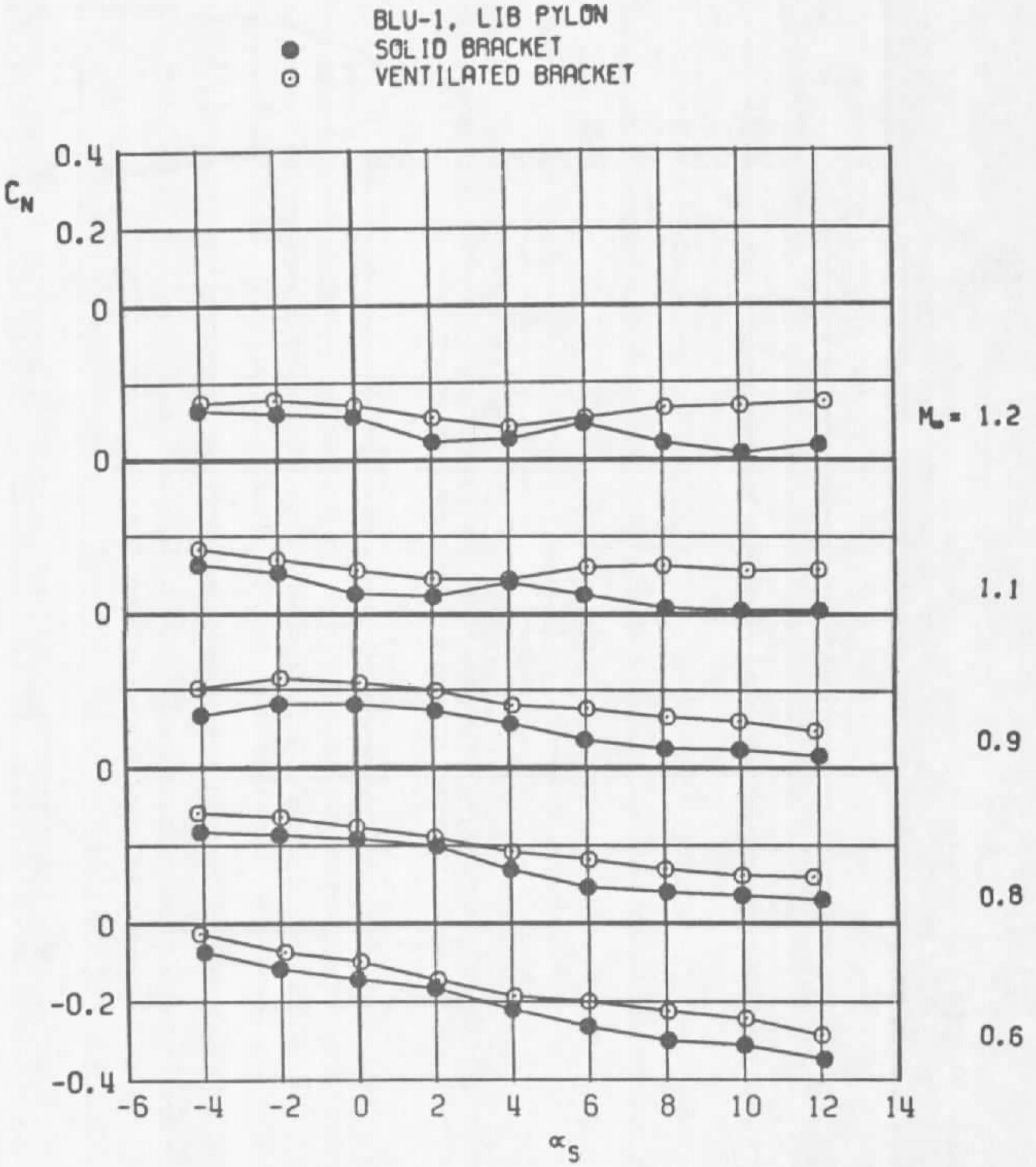
b. Increment in rolling-moment coefficient
Figure 13. Concluded.



a. Fundamental axial-force coefficient data
Figure 14. Effect on axial-force coefficient of a ventilated bracket supporting the HSM.

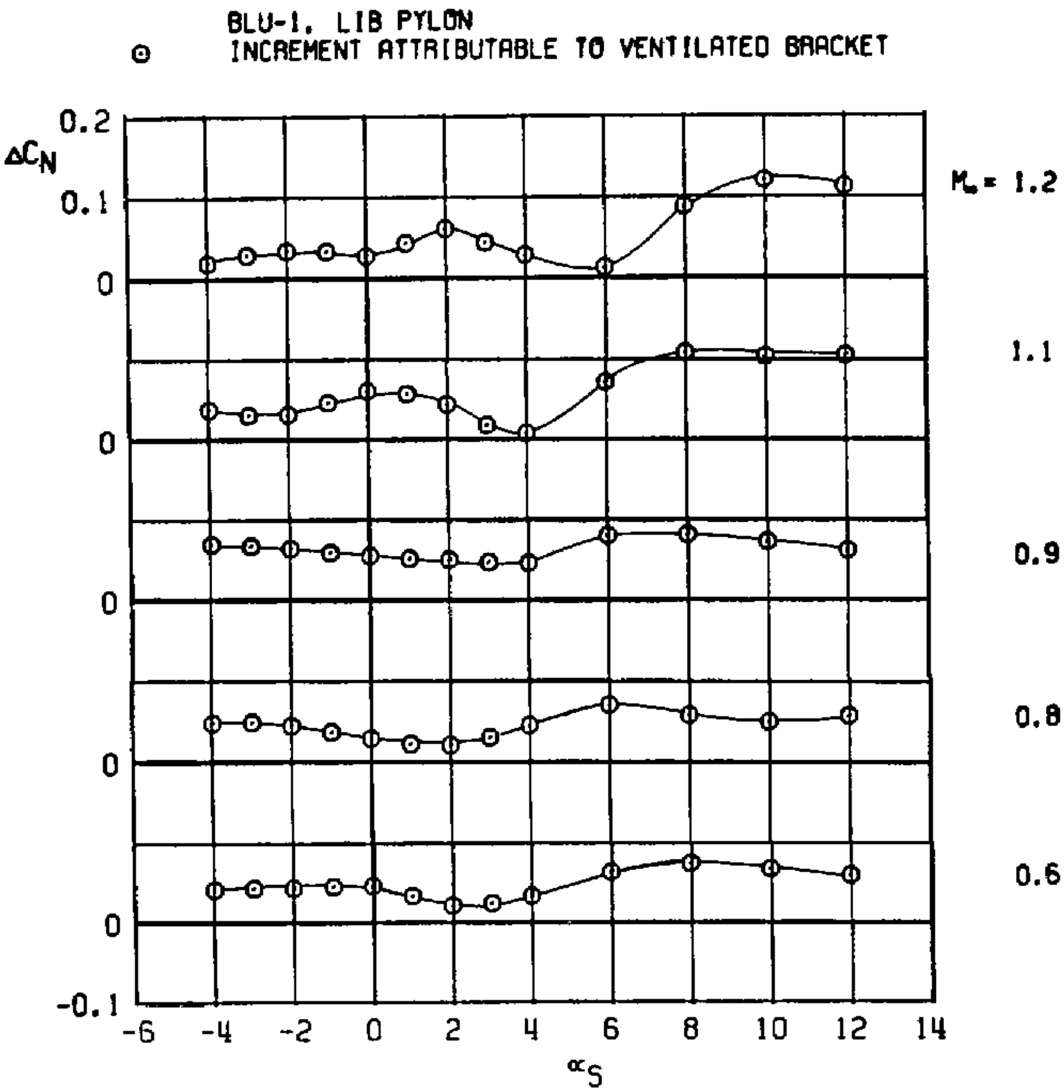


b. Increment in axial-force coefficient
Figure 14. Concluded.

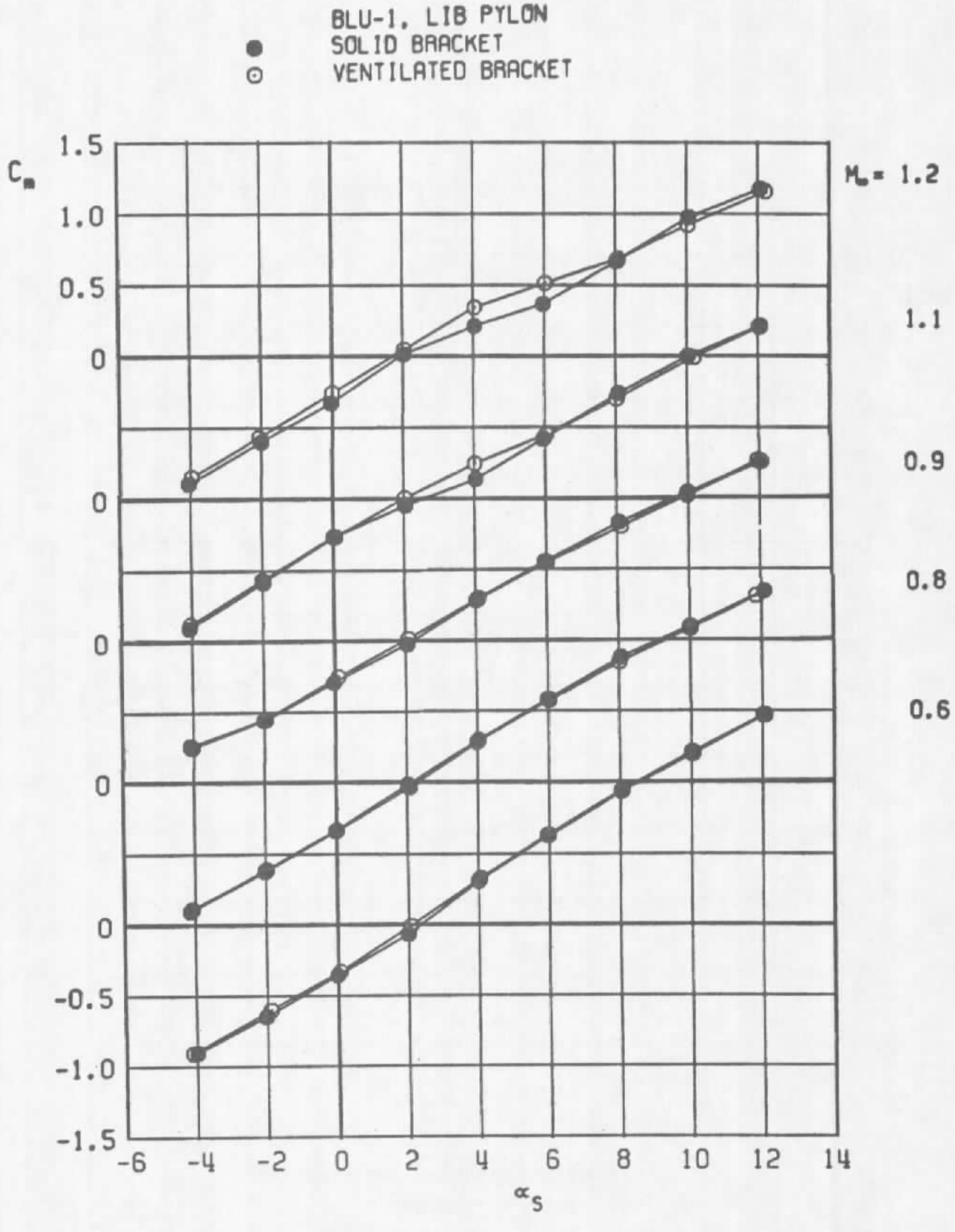


a. Fundamental normal-force coefficient data

Figure 15. Effect on normal-force coefficient of a ventilated bracket supporting the BLU-1.

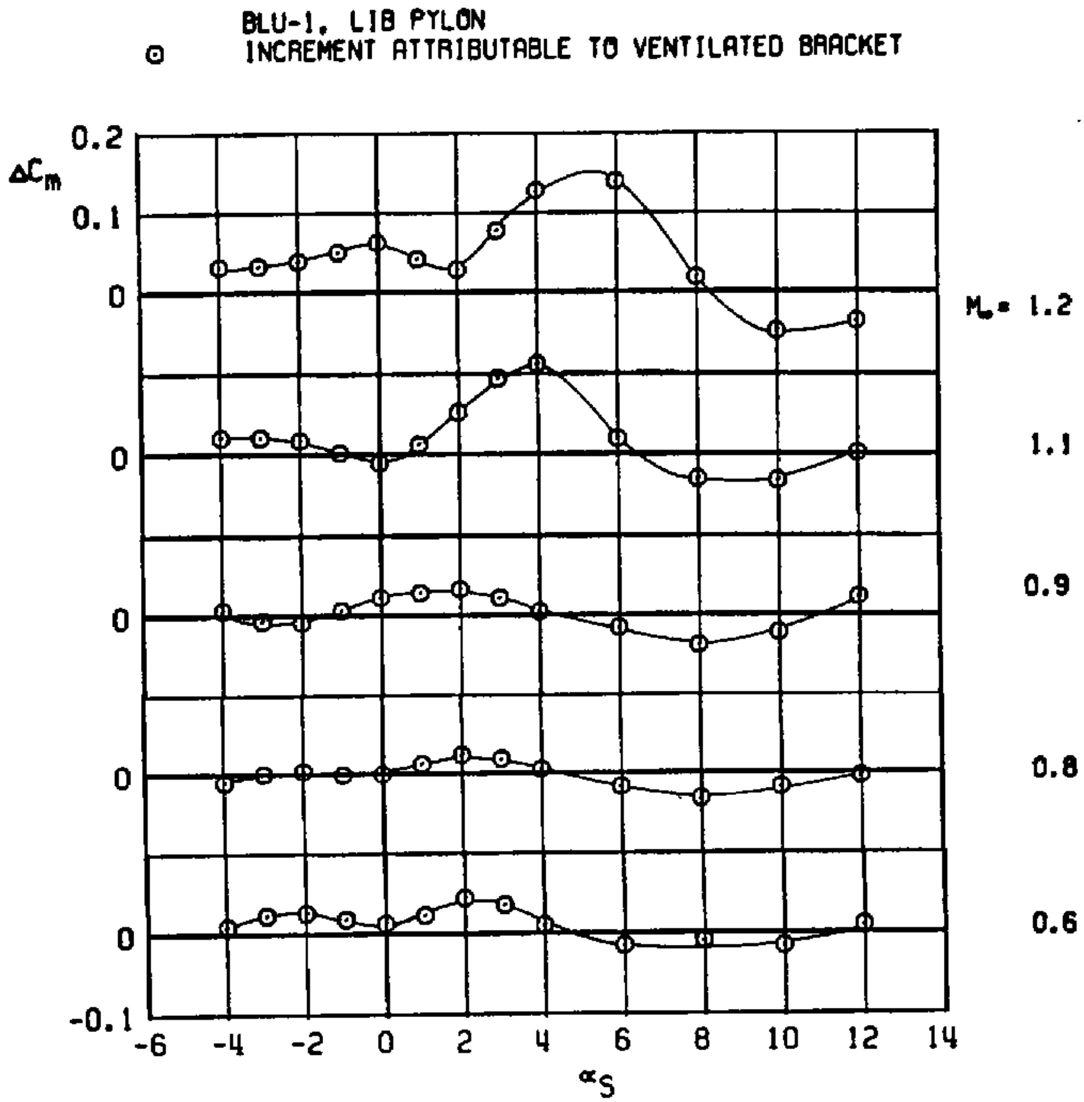


b. Increment in normal-force coefficient
Figure 15. Concluded.

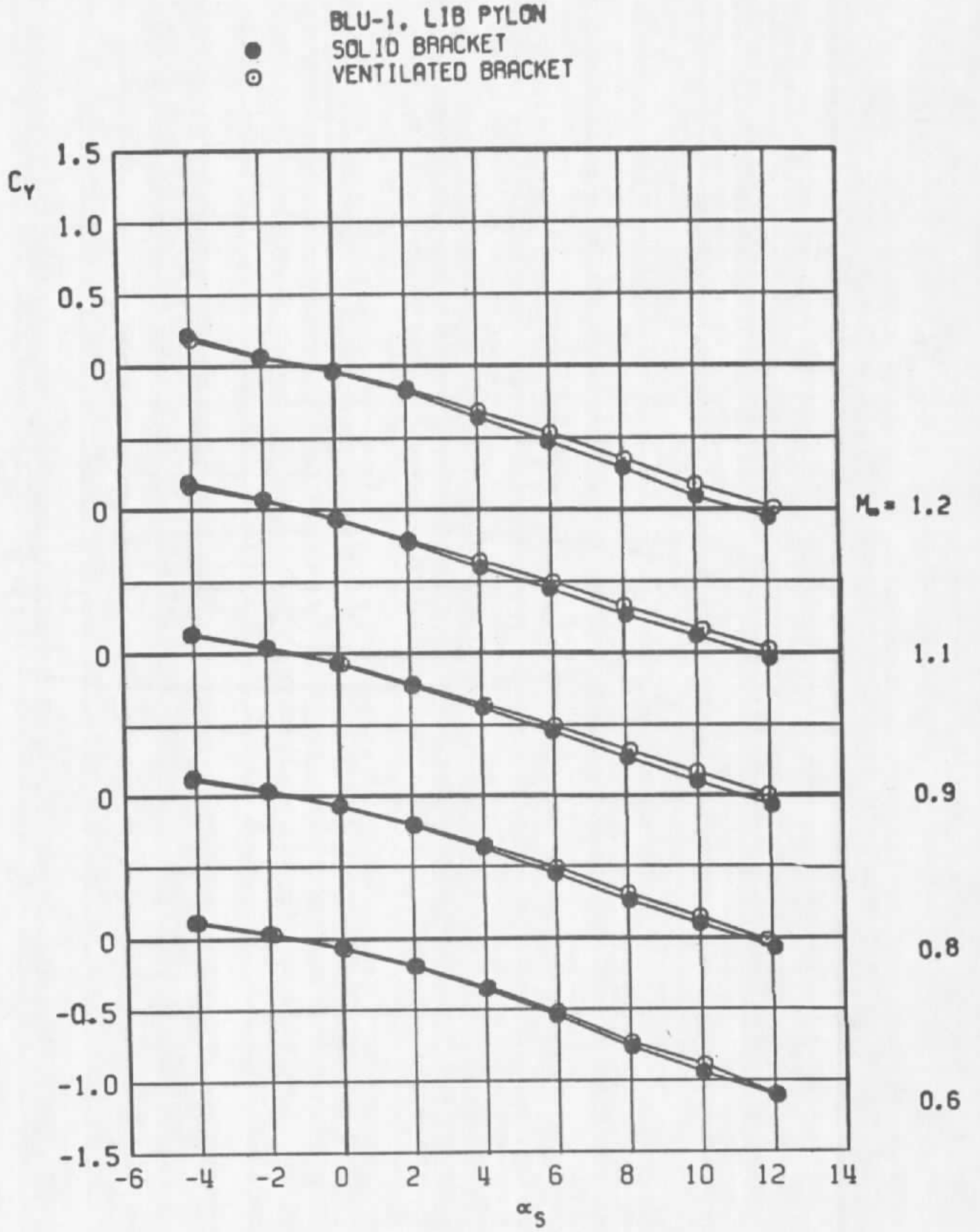


a. Fundamental pitching-moment coefficient data

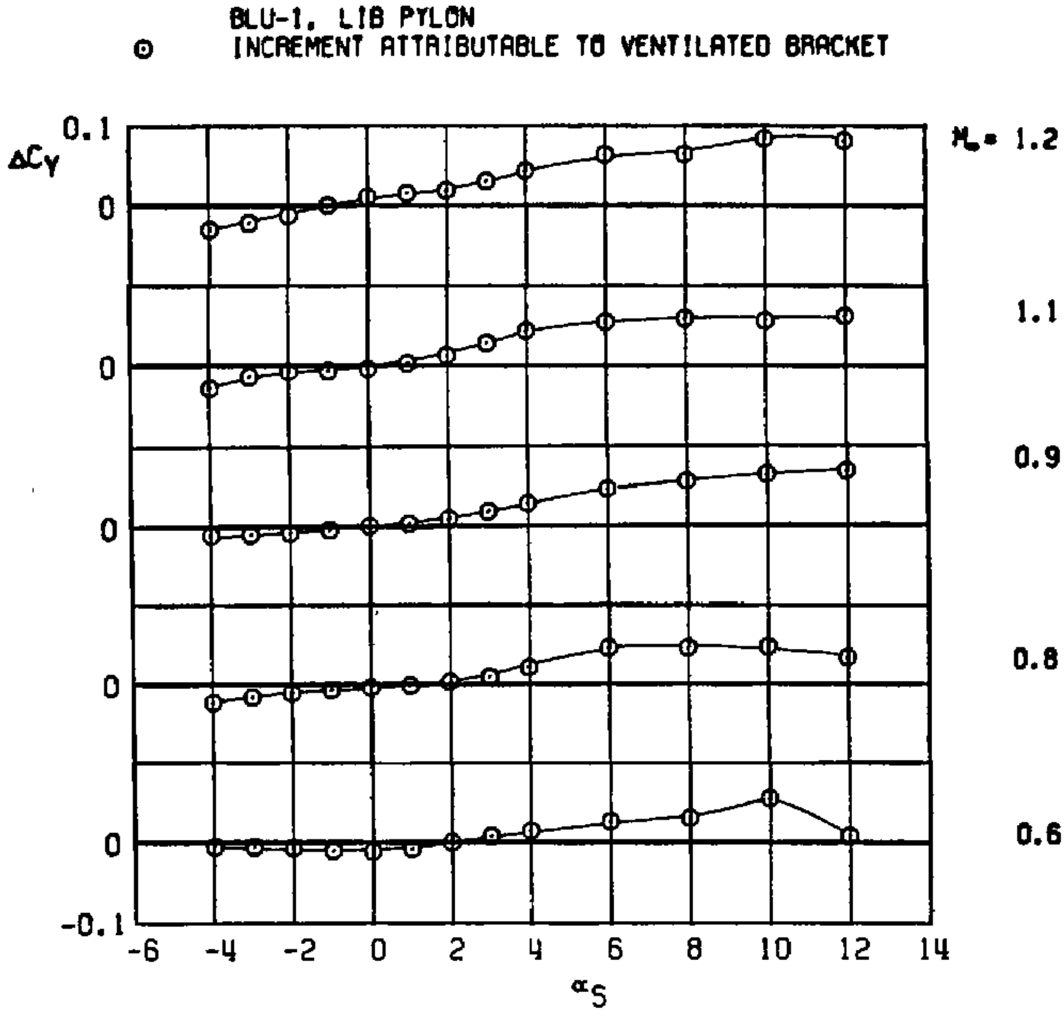
Figure 16. Effect on pitching-moment coefficient of a ventilated bracket supporting the BLU-1.



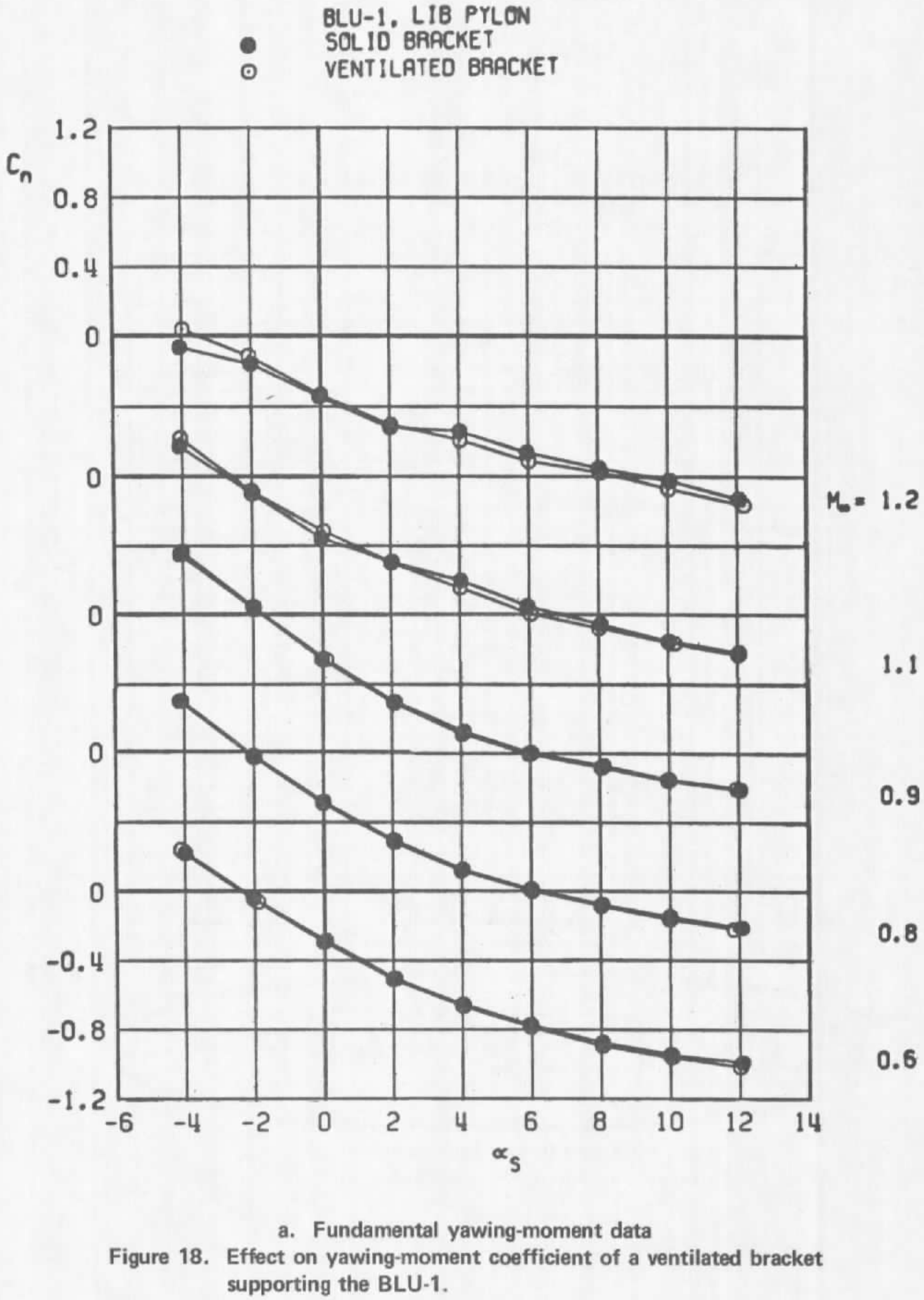
b. Increment in pitching-moment coefficient
Figure 16. Concluded.



a. Fundamental side-force coefficient data
Figure 17. Effect on side-force coefficient of a ventilated bracket supporting the BLU-1.

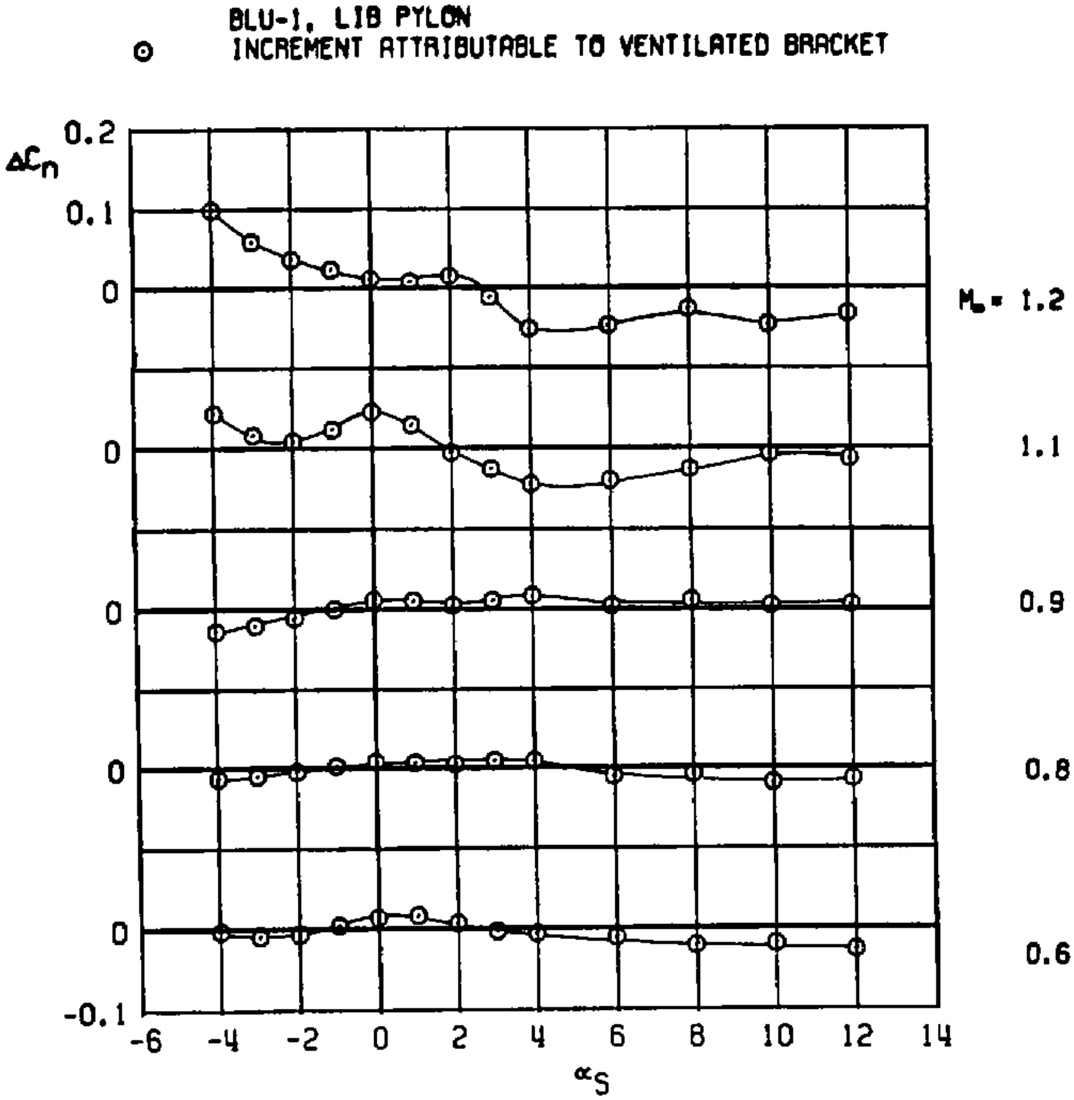


b. Increment in side-force coefficient
Figure 17. Concluded.

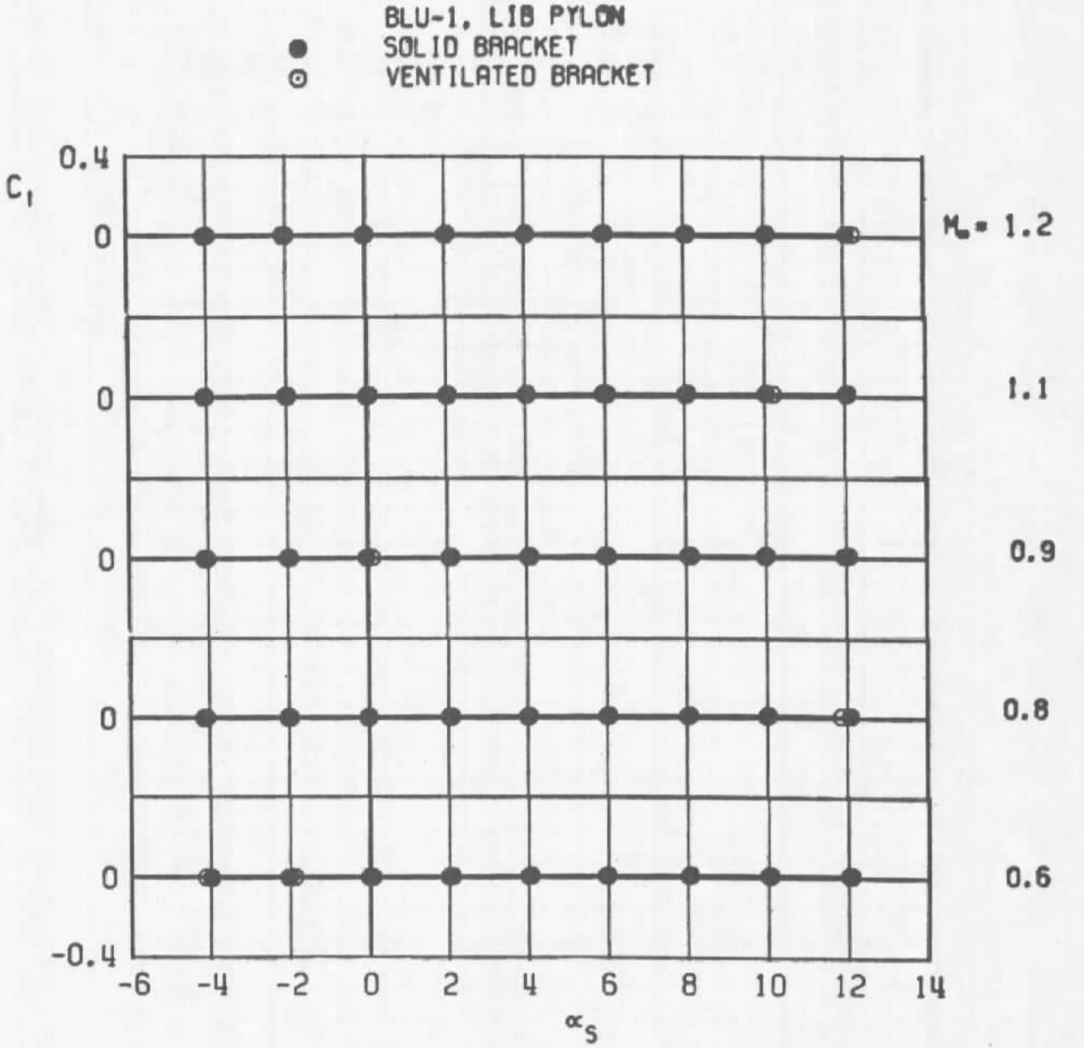


a. Fundamental yawing-moment data

Figure 18. Effect on yawing-moment coefficient of a ventilated bracket supporting the BLU-1.

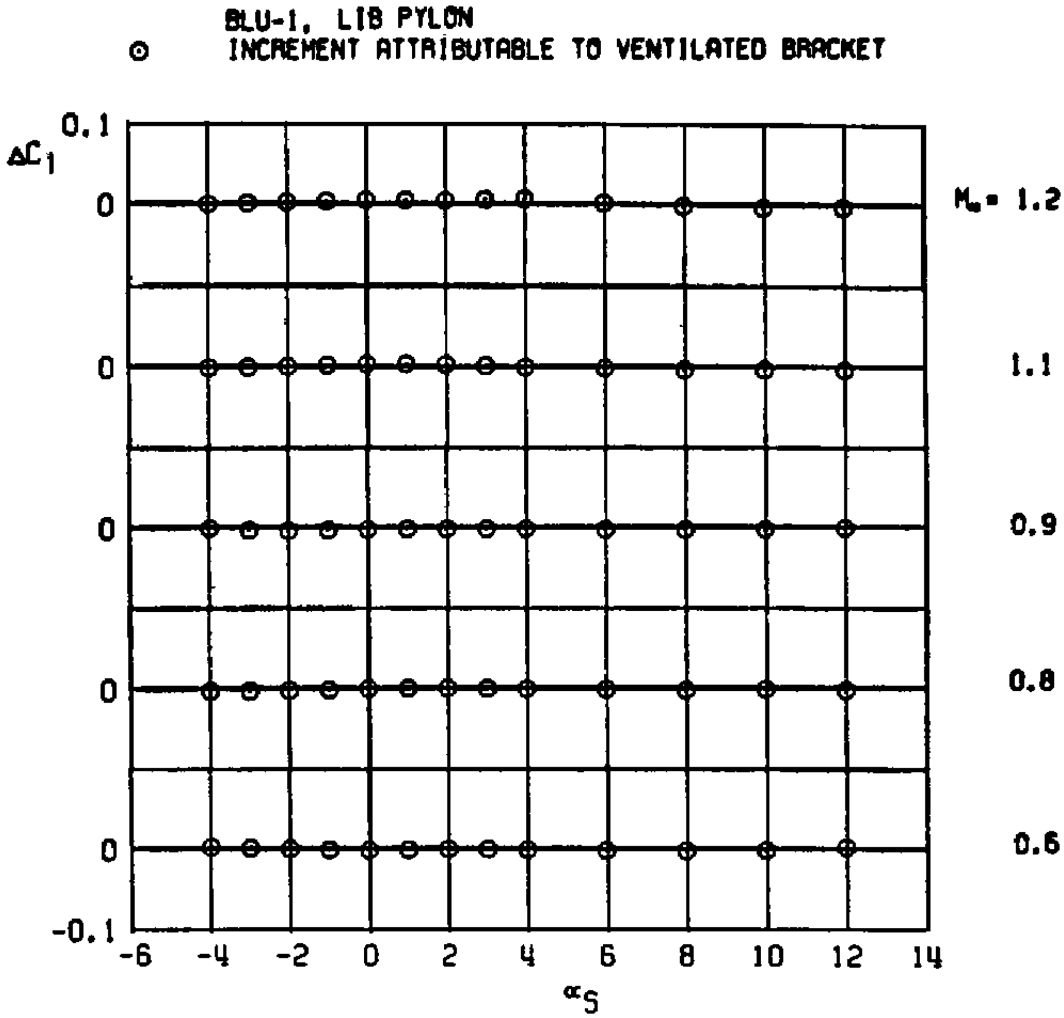


b. Increment in yawing-moment coefficient
Figure 18. Concluded.

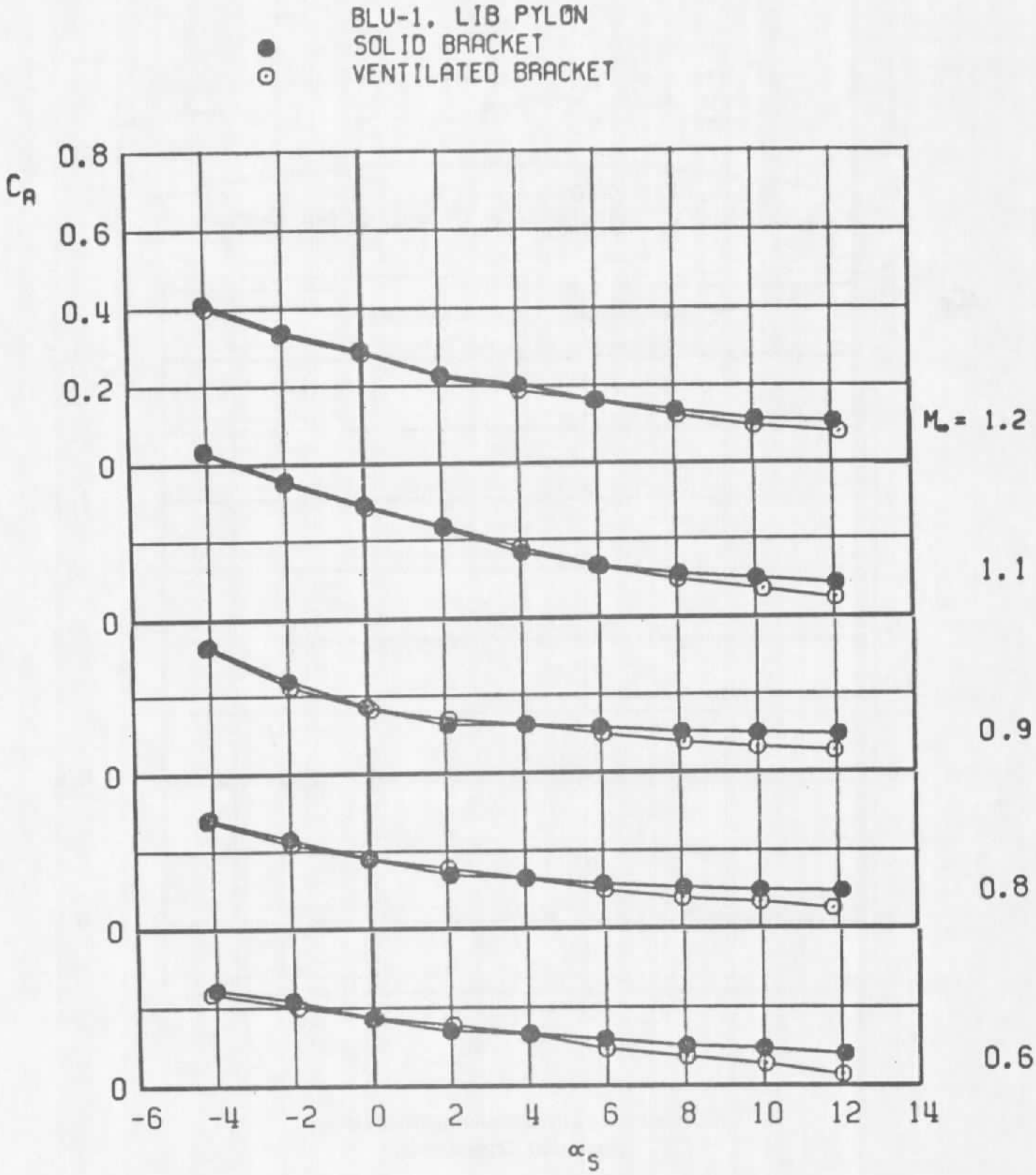


a. Fundamental rolling-moment coefficient data

Figure 19. Effect on rolling-moment coefficient of a ventilated bracket supporting the BLU-1.

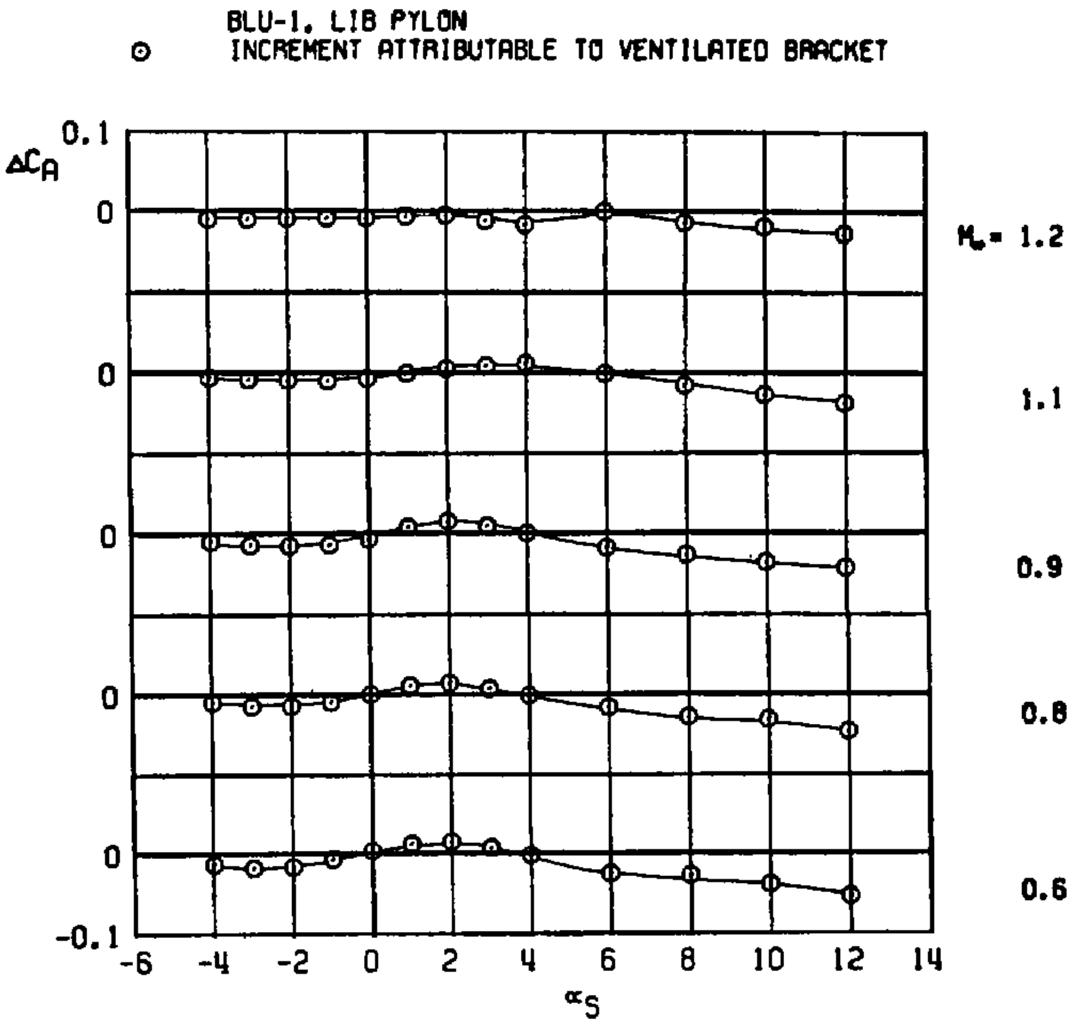


b. Increment in rolling-moment coefficient
Figure 19. Concluded.



a. Fundamental axial-force coefficient data

Figure 20. Effect on axial-force coefficient of a ventilated bracket supporting the BLU-1.



b. Increment in axial-force coefficient
Figure 20. Concluded.

NOMENCLATURE

BL	Aircraft buttock line, measured from the plane of symmetry, in. model scale
℄	Centerline
C_A	Coefficient of measured axial force acting on a store, measured axial force/$q_\infty S$
C_ℓ	Coefficient of measured rolling moment acting about the axis of symmetry of a store, measured rolling moment/$q_\infty SD$
C_m	Coefficient of measured pitching moment acting about the center of gravity of a store, measured pitching moment/$q_\infty SD$
C_N	Coefficient of measured normal force acting on a store, measured normal force/$q_\infty S$
C_n	Coefficient of measured yawing moment acting about the center of gravity of a store, measured yawing moment/$q_\infty SD$
C_Y	Coefficient of measured side force acting on a store, measured side force/$q_\infty S$
D	Maximum diameter of a store, in. model scale
FS	Fuselage station of the aircraft model, in. model scale
LIB	Left inboard
M_∞	Free-stream Mach number

p_∞ Free-stream static pressure, psfa

p_{t_∞} Free-stream total pressure, psfa

q_∞ Free-stream dynamic pressure, $0.7 p_\infty M_\infty^2$, psfa

R Radius

S Reference area of a store model (maximum cross-sectional area), $\frac{\pi D^2}{4(144)}$, ft^2

WL Waterline of the aircraft model, measured from the horizontal reference plane of the aircraft, in. model scale

α_s Gravimetric angle of attack of a store model, deg

ΔC_x Increment in a measured force or moment coefficient attributable to use of a ventilated bracket, (coefficient with ventilated bracket) minus (coefficient with solid bracket)

$\varepsilon(C_x)$ Uncertainty interval of a measured force or moment coefficient