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AEROSPACE INFORMATION REPORT

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Superseding AIR1353B

Cushion Tow Hitches Test

RATIONALE

The technology in this document is mature and not dynamic in nature.

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1. SCOPE:

The main purpose of this test was to determine the application advantages of cushion tow hitches in comparison to the commonly used rigid tow hitch type fitted on heavy aircraft towing tractors.

As diverse opinions emerged about its suitability since the introduction on the market of this new tow hitch type, it was intended to physically measure and evaluate the damping capability of this cushioned tow link when applied in practice.

2. REFERENCES:

There are no referenced publications specified herein.

3. PROCEDURE:

3.1 Similar to the tow and push out load test carried out in 1972, the tractive effort characteristic was measured of 20 loaded[1] B-747B aircraft at Zurich-Airport, towed by International Harvester Corporation (IHC) T-800 S tractor equipped with cushion tow hitches as well as with the standard rigid hitch type.

3.2 The test equipment as described under Section 4 was mainly supplied by the High National College of Technology KTB of Berne at Biel (Switzerland).

The calibration on the towbars was done by the Swiss Federal Research Centre (EMPA) in Zurich.

[1] Average gross weight of the test aircraft was 272,400 kg (600,000 lb).

3.3 The cushion hitch test was carried out at Zurich Airport by normal aircraft towing procedures on the different tow-out ways. The climatic conditions in July and August 1973 were favorable. The recorded tow load values of each single run were then evaluated in order to show graphically the maximum amplitude of the alternate push and pull loads (damping characteristic) measured while towing B-747 aircraft with standard and cushioned type hitches. Tow hitches instrumentation and sample recorded results are shown in Figures 1 through 5.

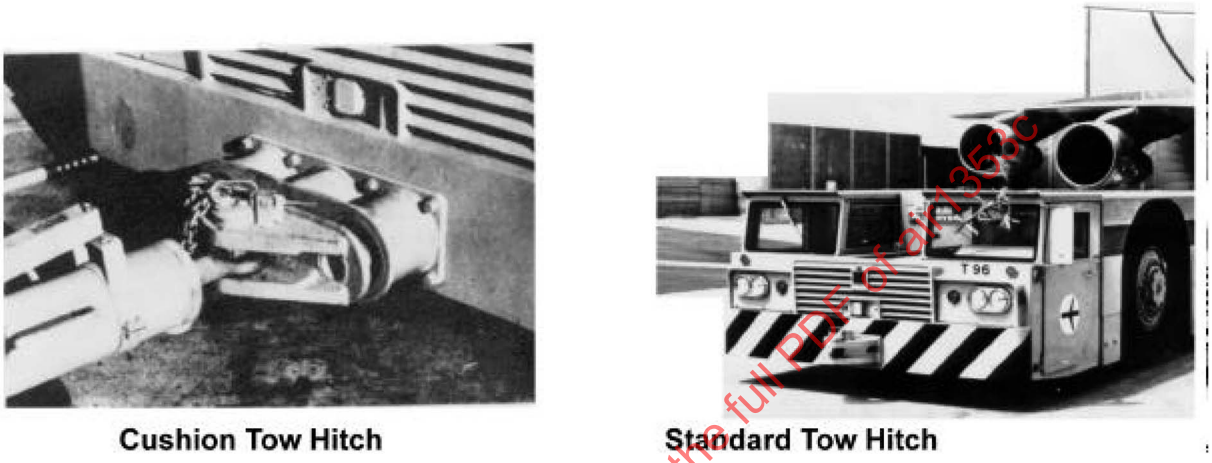

FIGURE 1 - Tow Hitches

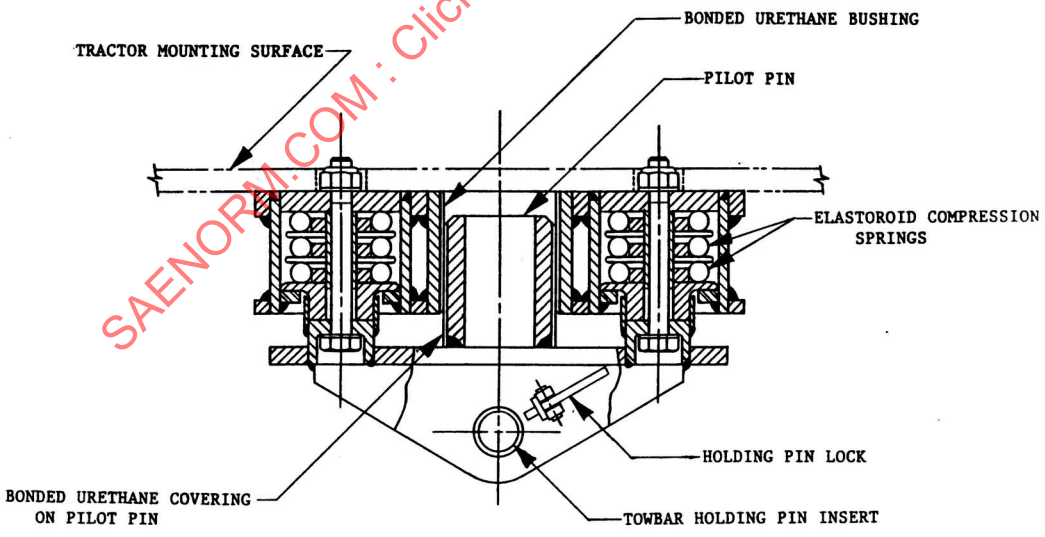

FIGURE 2 - Plan View - Cushion Hitch Assembly

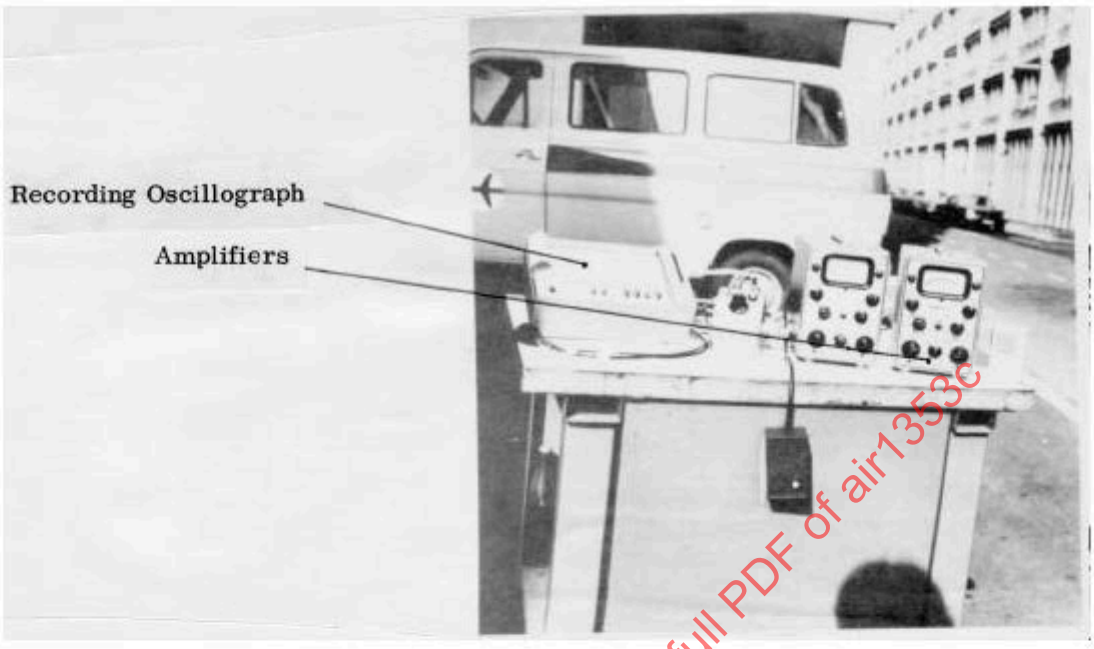

FIGURE 3 - Test Instruments

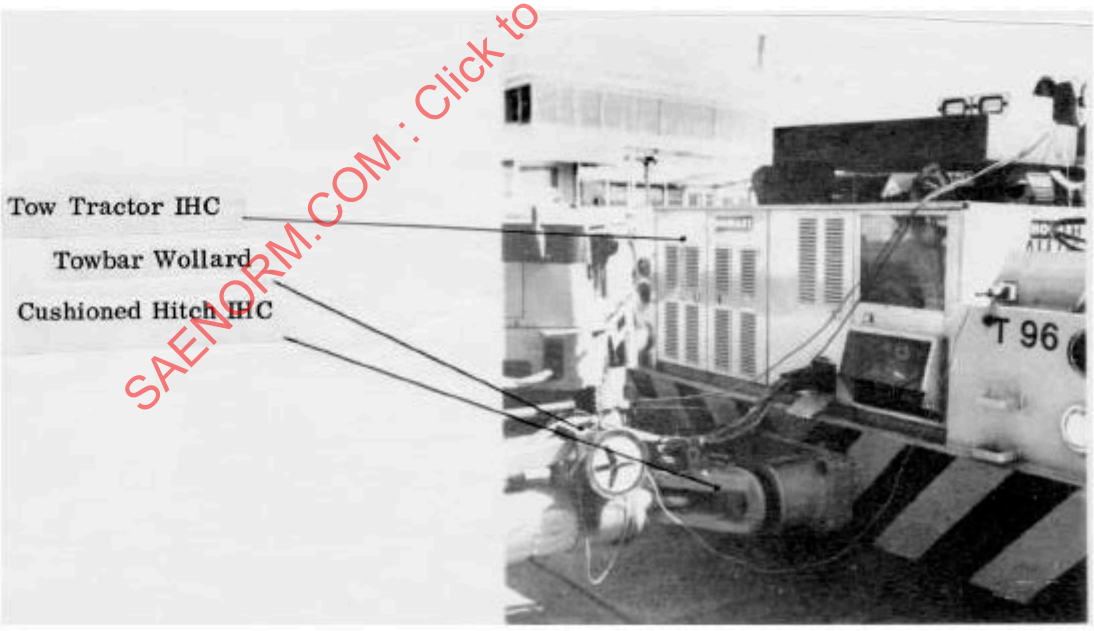

FIGURE 4 - Test Equipment Installed on Towing Tractor

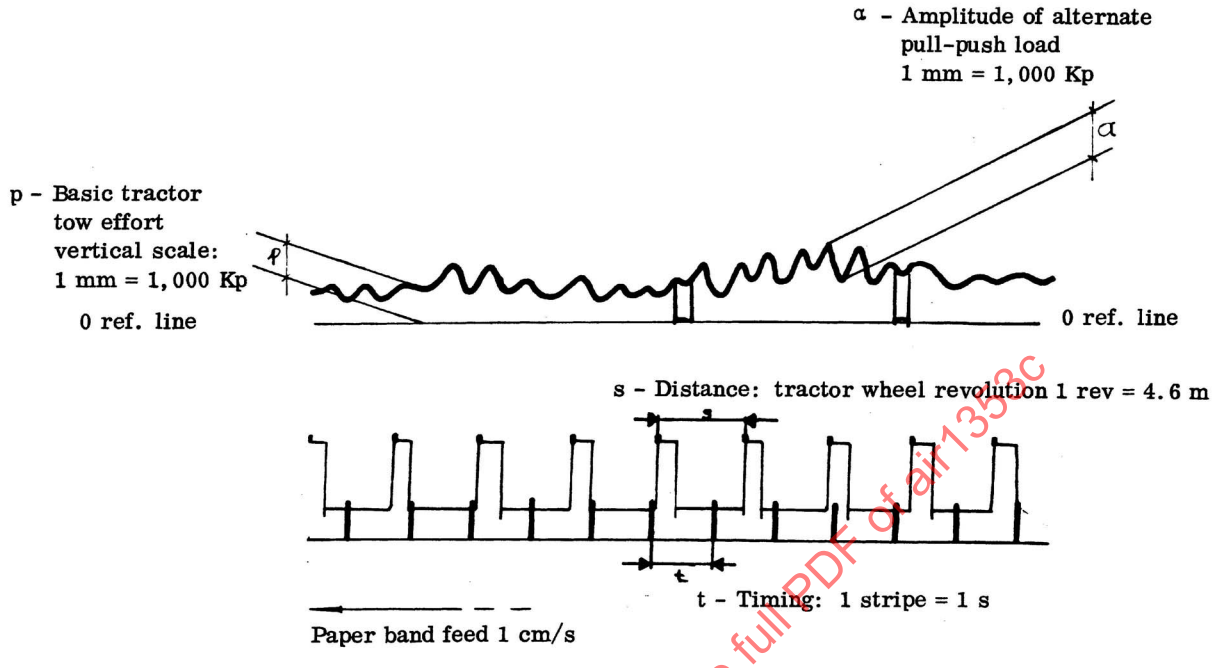

FIGURE 5 - Sample of Kodak Recorded Paper Band

4. TEST EQUIPMENT:

The following equipment was used for the testing:

a. 2 tractors (IHC T 800 S Paymover) weighing 110,000 lb
b. 2 cushion hitches (IHC) (pin type)
c. 1 towbar (Wollard TB-561) fitted with 4 elongation strain gauges placed at the towbar eye neck
d. 2 DC amplifiers (Hottinger Baldwin) to amplify tow loads inputs
e. 1 recording oscillograph "Kyowa" with 6 channels to record all inputs as speed, push and pull loads, aircraft NLG angle, on photographic paper band
f. Photographic recording paper (Kodak)
g. Boeing B-747-257 B aircraft, average weight, 275 tons

5. ENVIRONMENTAL CONDITIONS:

5.1 The airport of Zurich-Kloten where all tests were carried out is located 425 m (1390 ft) above sea level.

5.2 The maximum grade encountered on the aircraft (A/C) towing ways was 7.1°.

5.3 Tarmac and climatic conditions were always favorable. The average day temperature was 22.5 °C (72 °F) and the relative humidity 56%.

6. EVALUATION CRITERIA AND RESULTS:

6.1 Test results were basically divided and evaluated in 3 sections, each section corresponding to a major towing moment as follows:

a. Section 1 - towing start maneuvers
b. Section 3 - turns and straight-on maneuvers
c. Section 4 - towing stop maneuvers

The reason for this was to better distinguish and recognize the cushion hitch characteristic in respect to pull and push peak efforts while pulling up, changing direction, or slowing down with the towing tractor, when most of the vibrations between tractor and aircraft occur.

The maximum alternative pull and push loads (vibrations) of each run recorded on the photographic paper were read-out, statistically registered, and plotted on 3 diagrams (see Figures 6, 7, and 8). Each diagram shows the maximum pull/push load amplitude with and without cushion hitch registered in function of the towing tractor speed.

6.2 As a summary of the evaluated test results it appears that on the average the alternative load amplitudes recorded with the cushion tow hitch were 44% lower as with the rigid tow hitch.

The average reduction of load frequency with cushion tow hitch was 24%.

For each single case the average values in kilograms and pounds are as follows in Tables 1 and 2:

TABLE 1 - Alternate Towing Load Amplitude

	Without Cushion Hitch	With Cushion Hitch	Change in % with Cushion Hitch	Tractive Effort Average Basic Tow Load - Range
Towing Start Maneuver	3,520 kg (7,760 lb)	2,250 kg (4,960 lb)	-36	8,000 - 11,000 kg (17,630 - 24,250 lb)
Turns and Straight-on Maneuver	3,540 kg (7,820 lb)	1,704 kg (3,750 lb)	-52	6,000 - 7,000 kg (13,270 - 15,430 lb)
Slow-Down Maneuver	5,030 kg (11,089 lb)	2,800 kg (6,170 lb)	-44	10,000 - 16,000 kg (22,040 - 35,200 lb)

NOTE: Base for 100% = Maximum value recorded with rigid tow hitch.

TABLE 2 - Towing Load Frequency

	Without Cushion Tow Hitch	With Cushion Tow Hitch	Change with Cushion Hitch
Towing Start Maneuver	1.25	1.20	-4%
Turns and Straight-on Maneuvers	1.6	0.95	-40%
Slow Down and Stop	1.35	1.04	-23%

7. GRAPHICAL RESULT REPRESENTATION:

   (See Figures 6, 7, and 8):

8. CONCLUSION:

   This test clearly showed the positive damping properties of the IHC cushion tow hitch under the every day airport towing situations as it reduced considerably the alternate push and pull loads as well as the alternate load frequency.

PREPARED BY SAE SUBCOMMITTEE AGE-2C, VEHICLE MAINTENANCE AND AIRCRAFT SERVICING OF COMMITTEE AGE-2, AIR CARGO AND AIRCRAFT GROUND EQUIPMENT AND SYSTEMS

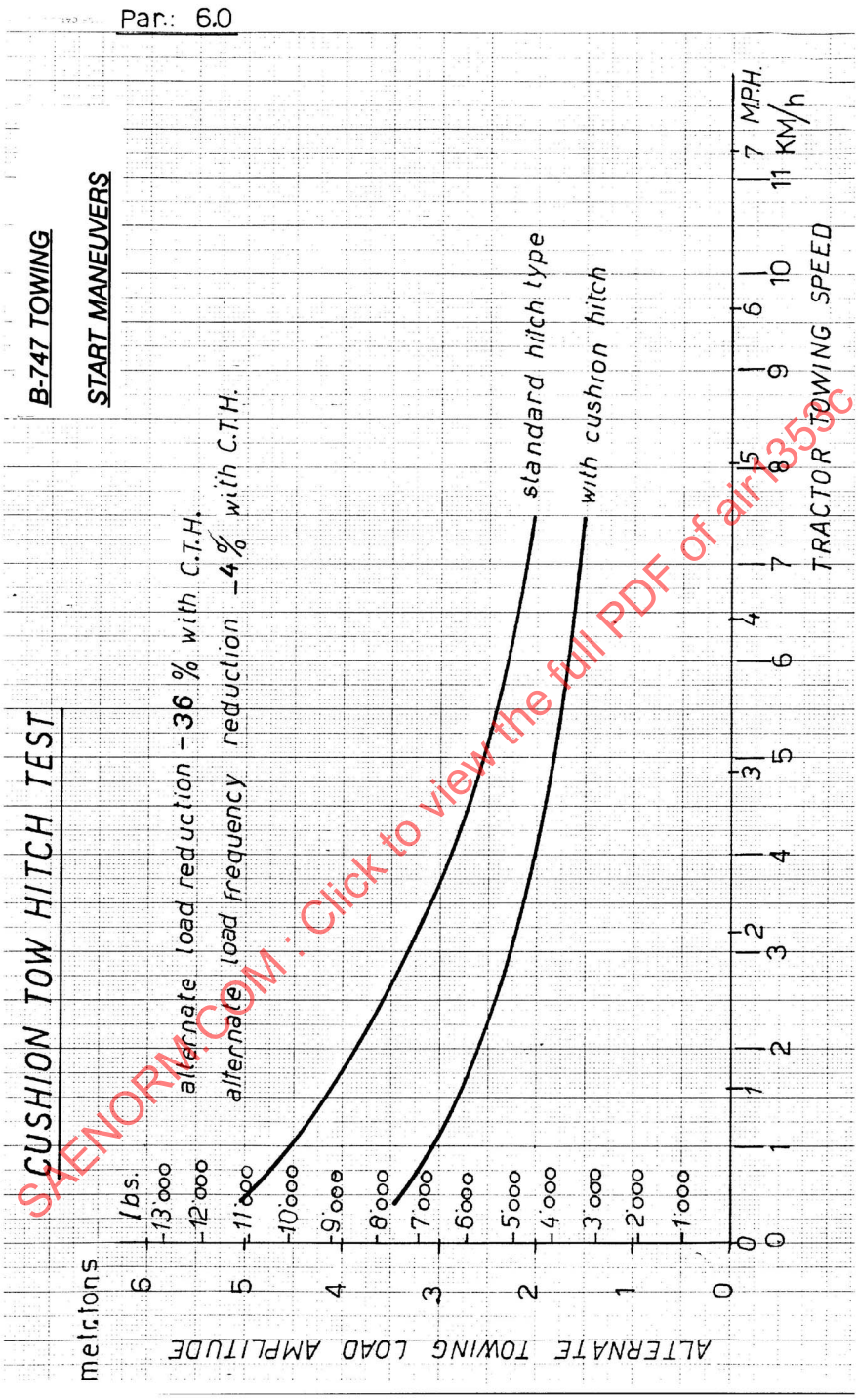

FIGURE 6 - Diagram 1 - Average Basic Tractive Effort Range 8 to 11 tons (17,630 to 24,250 lb)