AEROSPACE INFORMATION REPORT

AIR 1353

Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

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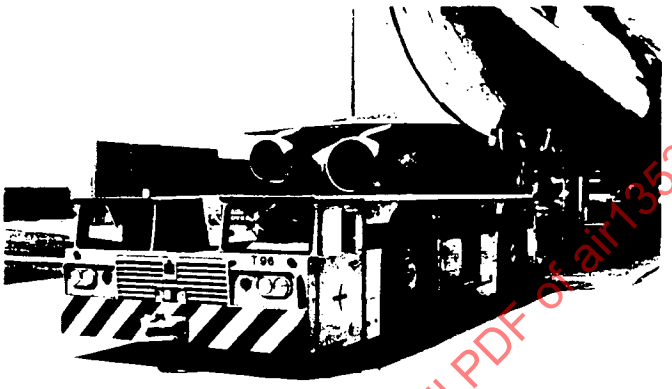
Revised

CUSHION TOW HITCHES TEST



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.

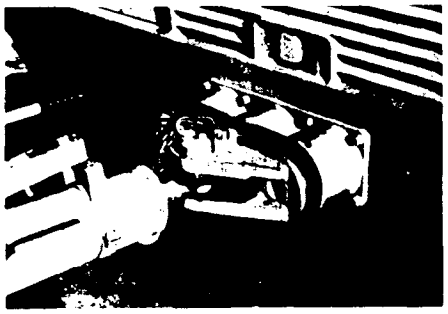
2. PROCEDURE

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

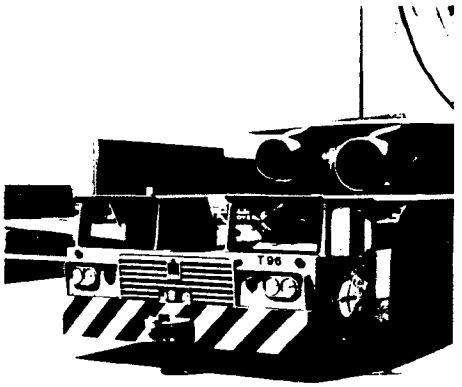
2.2 The test equipment as described under para. 3 was mainly supplied by the High National College of Technology KTB of Berne at Biel (Switzerland).

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

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



Cushion Tow Hitch



Standard Tow Hitch

FIGURE 1

2.3 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 max. amplitude of the alternate push and pull loads (damping characteristic) measured while towing B-747 aircraft with standard and cushioned type hitches.

3. TEST EQUIPMENT

The following equipment was used for the testing:

a) 2 tractors (IHC T 800 S Paymover) weighing 110,000 lbs

b) 2 cushion hitches (IHC) (pin type)

c) 1 tow-bar (Wollard TB-561) fitted with 4 elongation strain gauges placed at the towbar eye neck

d) 2 D.C. 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

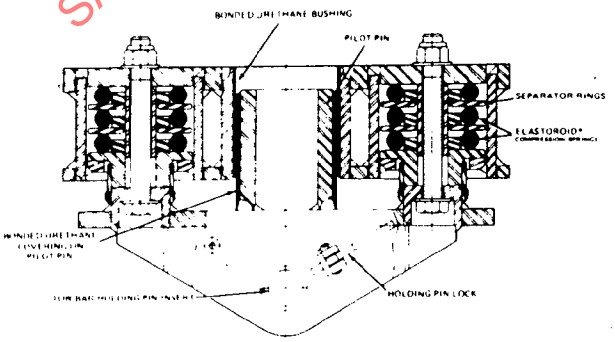


FIGURE 2 - PLAN VIEW - CUSHION HITCH ASSEMBLY

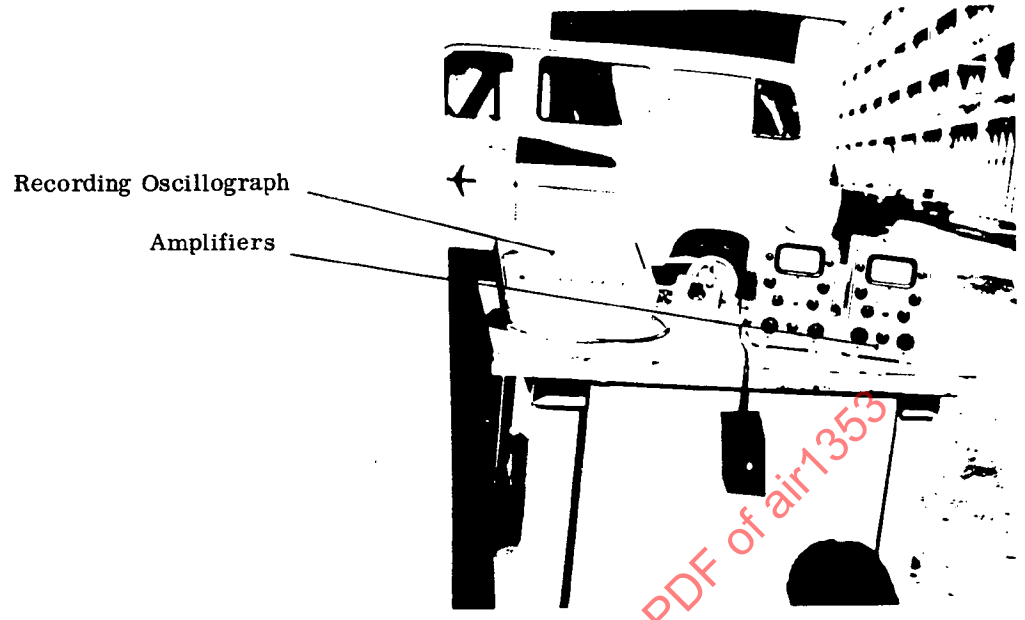


FIGURE 3 - TEST INSTRUMENTS

FIGURE 4 - TEST EQUIPMENT INSTALLED ON TOWING TRACTOR

4. ENVIRONMENTAL CONDITIONS

4.1 The airport of Zurich-Kloten, where all tests were carried out is located 425 m (1,390 ft) above sea level.

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

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

5. EVALUATION CRITERIA AND RESULTS

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

Section 1 - towing start maneuvers
Section 2 - turns and straight-on maneuvers
Section 3 - 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 max. 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 Diagrams 1, 2, and 3). Each diagram shows the max. pull/push load amplitude with and without cushion hitch registered in function of the towing tractor speed.

5.2 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 were as follows:

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

Base for 100% = max. value recorded with rigid tow hitch
C.H. = Cushion Hitch

	Towing Load Frequency Without Cushion T. H.	With Cushion T. H.	Reduction with C. H.
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%

Frequency = pull/push loads per second
C.H. = Cushion Hitch
T.H. = Tow Hitch

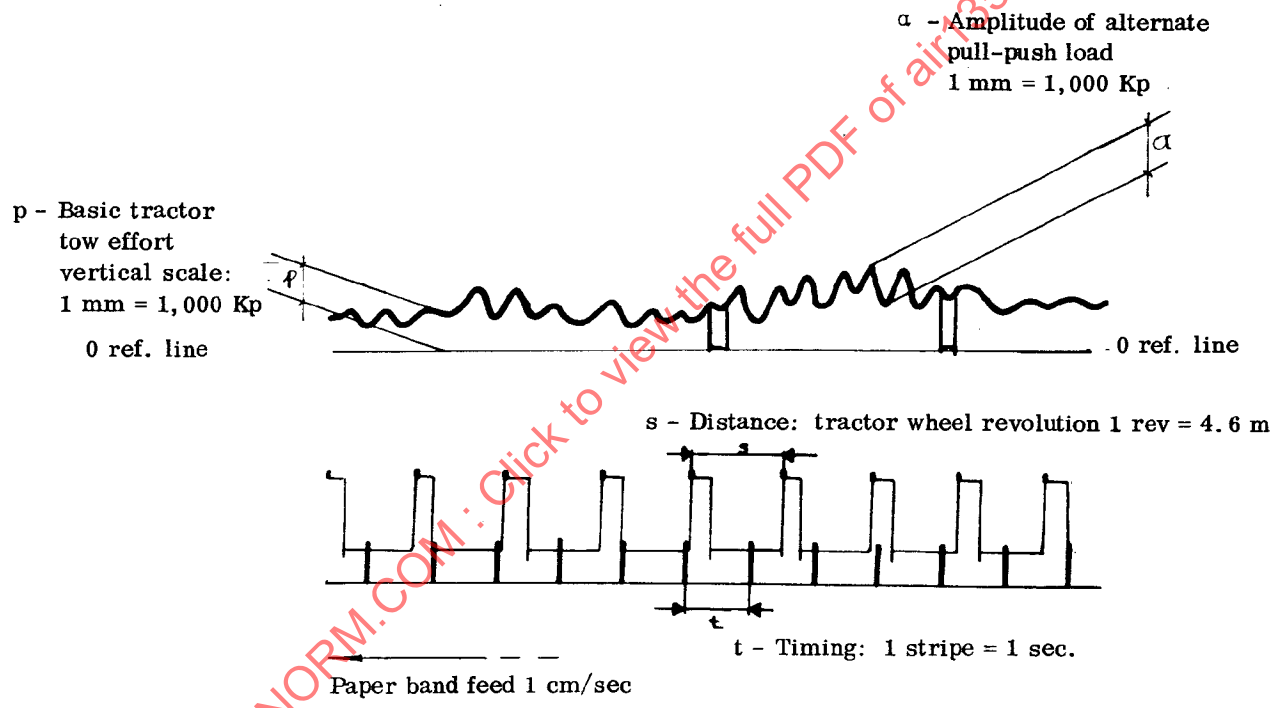


FIGURE 5 - SAMPLE OF KODAK RECORDED PAPER BAND

6. GRAPHICAL RESULT REPRESENTATION - See Diagrams 1, 2, and 3.

7. CONCLUSION

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

The 2 months period of this test, however, was not long enough to determine which direct improvements on towing equipment can be achieved by using cushion tow hitches. This would be possible only after a 1 - 2 yrs. experience by running both types of tow hitches side by side in the same A/C towing tractor fleet.

PREPARED BY

SAE COMMITTEE AGE-2, CIVIL AIRCRAFT GROUND SUPPORT EQUIPMENT

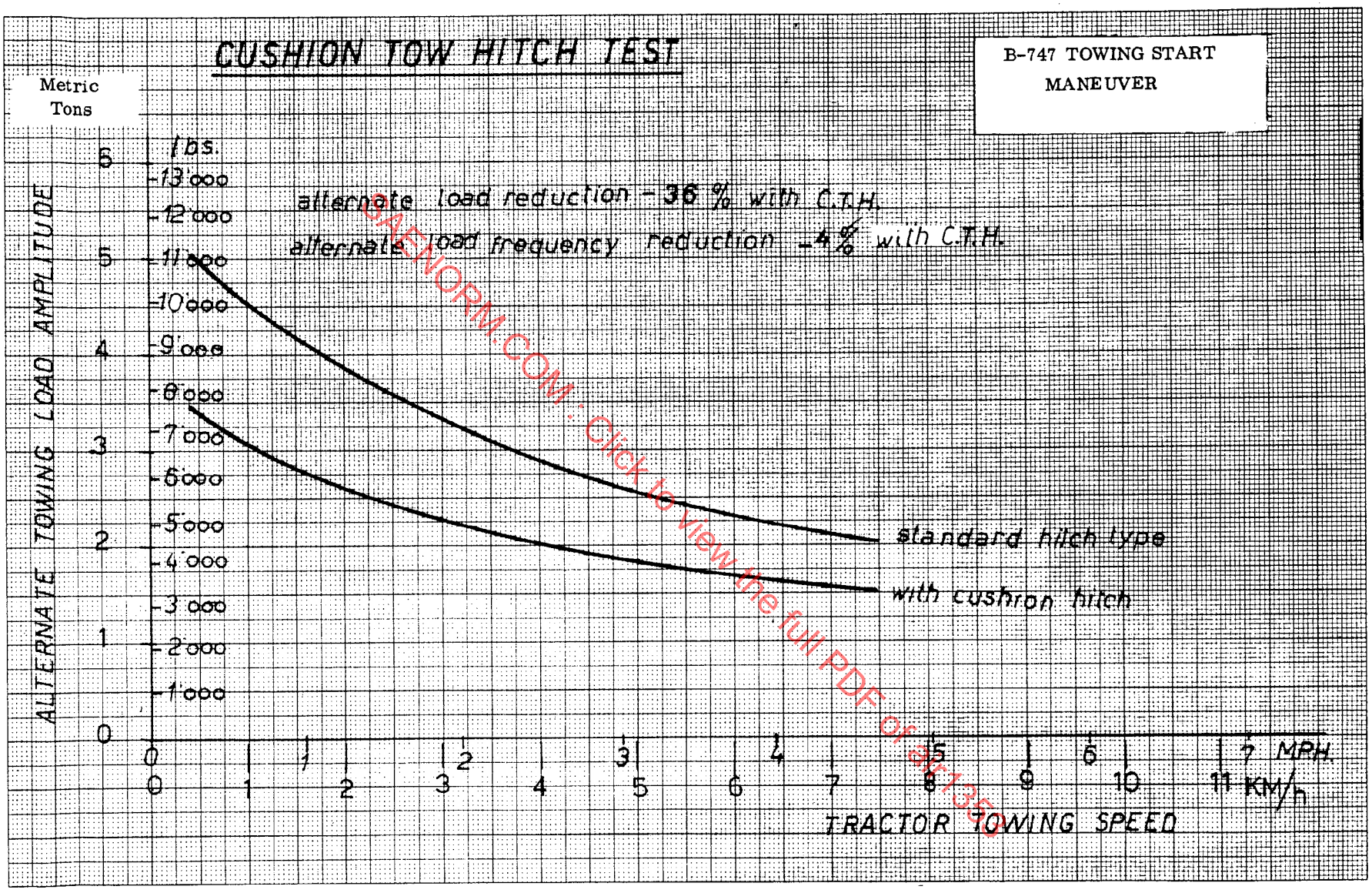


Diagram 1 - Average basic tractive effort range 8 - 11 tons (17,630 - 24,250 lbs)