Summary of the FAA's Research on Aircraft Cabin Overhead Stowage Bins

Federal Aviation Administration

Presented to: Sixth Triennial Int'l Fire and Cabin Safety Research Conference

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AGENDA

Introduction and Background

Description/results of Longitudinal Simulated Impact Tests

Description/results of Vertical Drop Impact Tests

Conclusions

PROGRAM OBJECTIVE

Determine the response characteristics of aircraft cabin overhead stowage bins when subjected to a severe, but survivable, impact condition.

Methodology

Conduct full-scale vertical impact tests and full-scale horizontal simulated impact tests.

Support the development/application of analytical modeling for crashworthiness.

BACKGROUND

Vertical Impact Tests - FAA William J. Hughes Technical Center

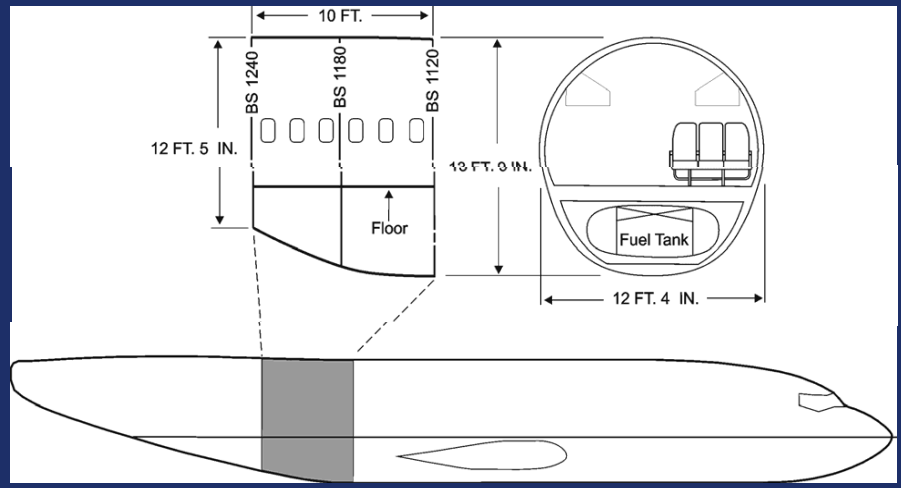
Boeing 707 – 10-foot section - 1993
Boeing 737 – 10-foot section - 2000
Analytical modeling Army Research Labs and Drexel University

Longitudinal Simulated Impact Tests – TRC Inc.

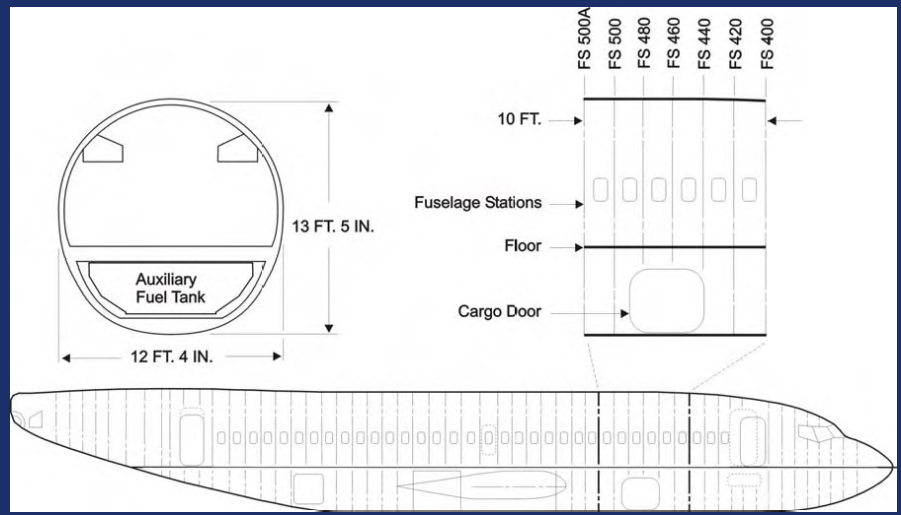
Boeing 707 – 10-foot section - 1991
Boeing 737 – 10-foot section - 1997

10-Foot Fuselage Section

Boeing 707



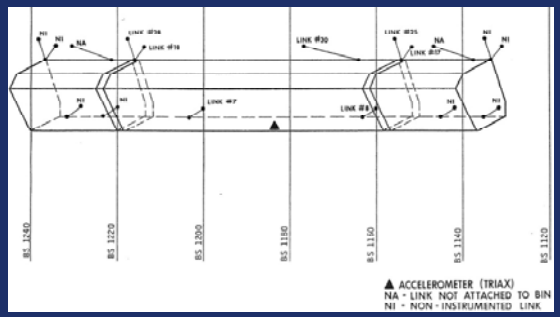
Boeing 737



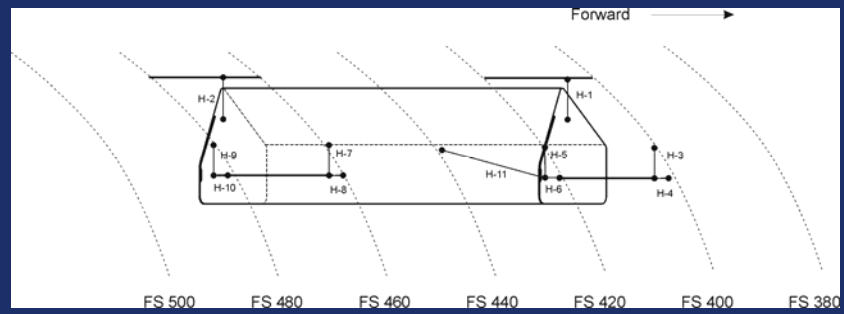
Overhead Stowage Bin Schematics

Longitudinal 707 Test

Boeing Bin

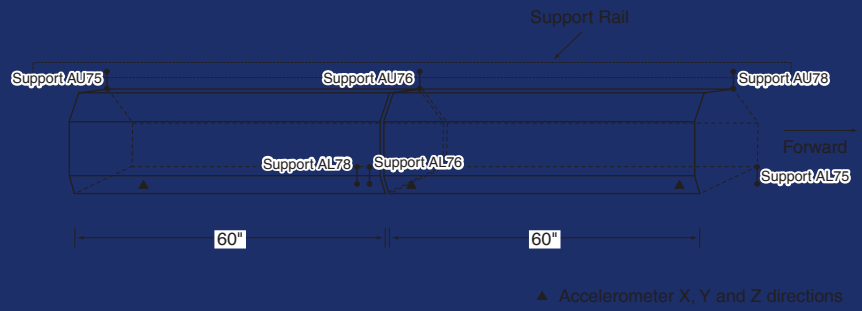


Hitco Bin

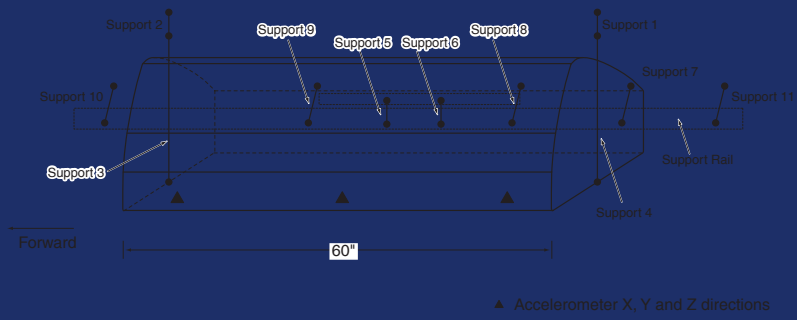


Longitudinal 737 Test

C&D Bin



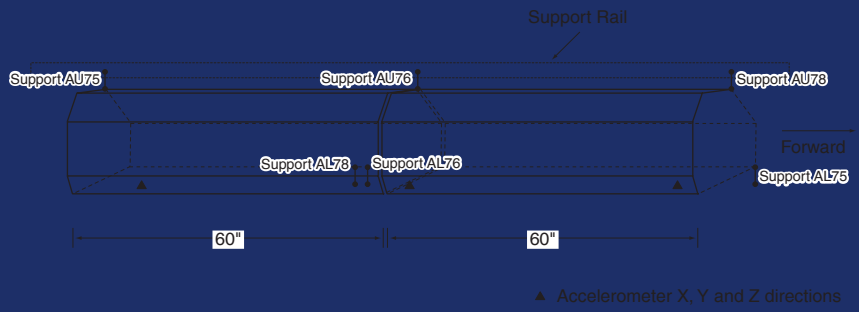
Hexcel Bin



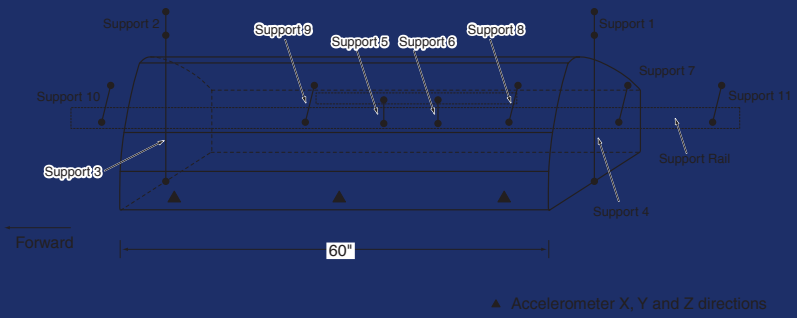
Overhead Stowage Bin Schematics

Vertical 707 Test

C&D Bin

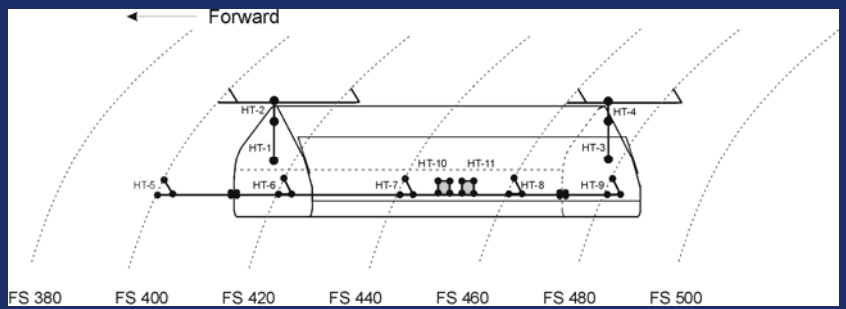


Hexcel Bin



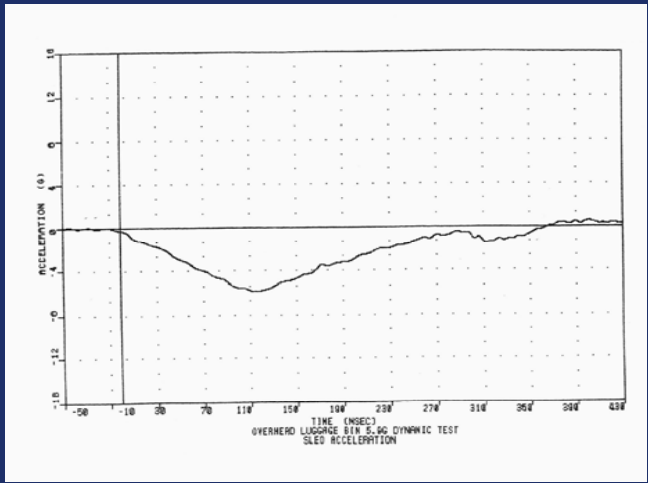
Vertical 737 Test

Heath Tecna Bin

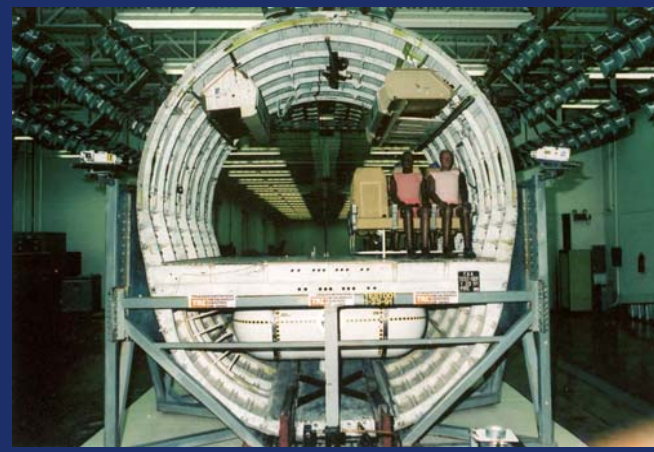


Hitco Bin

Longitudinal Simulated Impact Tests



Boeing 707



Triangular pulse
6-g, 9-g, 14-g

Bins strapped closed

Bins loaded to placard weight

Boeing 737

Longitudinal Results

Maximum Longitudinal Accelerations

Test section	Peak Acceleration (g)				Boeing Bin Left-Side Peak Acceleration (g)	Hitco Bin Right-Side Peak Acceleration (g)
	Sled	Floor	Sidewall	Crown		
Boeing 707	5.9	6.0	6.3	6.7	*	6.7
	8.8	9.1	9.6	10.3	**12.7	10.7
	13.2	14.5	14.9	15.1	*	17.4
Test section	Peak Acceleration (g)				***C&D Bin Left-Side Peak Acceleration (g)	***Hexcel Bin Right-Side Peak Acceleration (g)
	Sled	Floor	Sidewall	Crown		
Boeing 737	6.1	7.0	NA	NA	7.1 (6.9)	7.7 (7.0)
	8.2	8.6	NA	NA	10.1 (10.1)	9.0 (9.1)
	14.2	16.5	NA	NA	****14.7 (14.7)	16.7 (16.8)

100-Hz data. *Bin failed – still suspended. **Spike occurred approximately 20 msec prior to peak sled pulse, final reading 10.8g. ***Second reading () indicates measured load equivalent g-level. ****Bin detached after this reading.

Longitudinal Results

Static and Dynamic Influence Coefficients – Boeing 737

Support Member Time of Measurement	Longitudinal Component Influence Coefficient			
	Measured Static	Test 737-6 Dynamic	Test 737-9 Dynamic	Test 737-14 Dynamic
Hexcel 5	0.532	0.540	0.539	0.530
Hexcel 6	0.468	0.460	0.461	0.470
C&D AU75	0.247	0.221	0.198	0.192
C&D AU76	0.335	0.335	0.306	0.278
C&D AU78	0.025	0.033	0.066	0.103
C&D AL78	0.073	0.067	0.064	0.060
C&D AL76	0.186	0.208	0.205	0.206
C&D AL75	0.129	0.136	0.161	0.160

100-Hz data.

Longitudinal Results

Inertial Bin Accelerations

Bin	Maximum Inertial Load (g)			Maximum Inertial Load (g)			Maximum Inertial Load (g)		
	X-dir	Y-dir	Z-dir	X-dir	Y-dir	Z-dir	X-dir	Y-dir	Z-dir
	Test 707-6			Test 707-9			Test 707-14		
Hitco bin	6.7	±2	±2	**10.7**	±2	±2	****17.4**	+2/-4	+13/-10
Boeing bin	**	**	**	**12.7**	±2	±1	*	*	*
	Test 737-6			Test 737-9			Test 737-14		
C&D bin	6.9	±1	±2	**10.1**	±1	±1	*****14.7**	±2	±2
Hexcel bin	7.7	±2	±3	9.0	±1	±1	**16.7**	±1	±3

100-Hz data. * Bin failure – still suspended - PSU hanging. ** Bin failure - still suspended. *** Bin detached at 14.7g. Current bin certification requirements (25.561), X-dir +9/-1.5, y-dir ±3, z-dir -6/+3.

Longitudinal Results

PSU Detaches

Vertical Impact Test

- 10-foot section
- Bins Strapped closed
- Bins loaded to placard weight
- 18 passengers
- Test weight App.
  - B-707 8,100 lbs
  - B-737 8,900 lbs
- Drop height 14′
- Impact velocity 30 ft/s
- TC Part 25

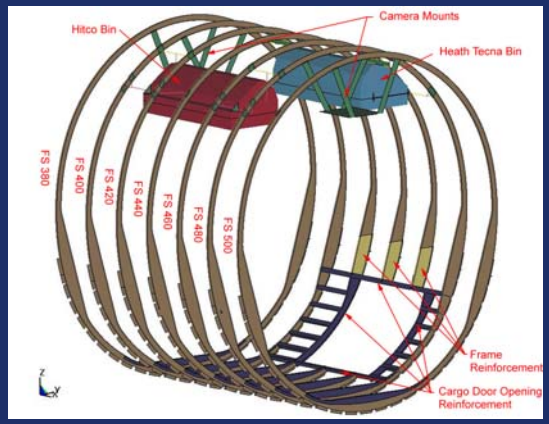
Boeing 707

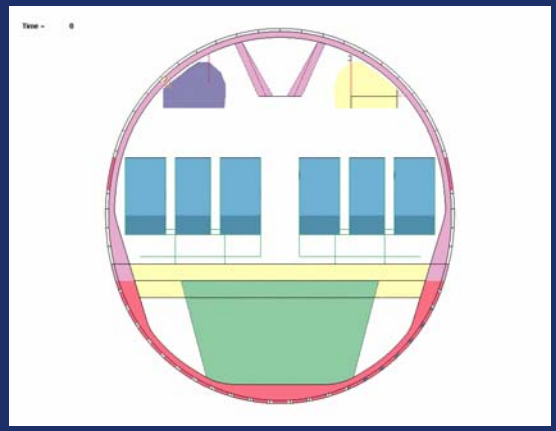
Boeing 737

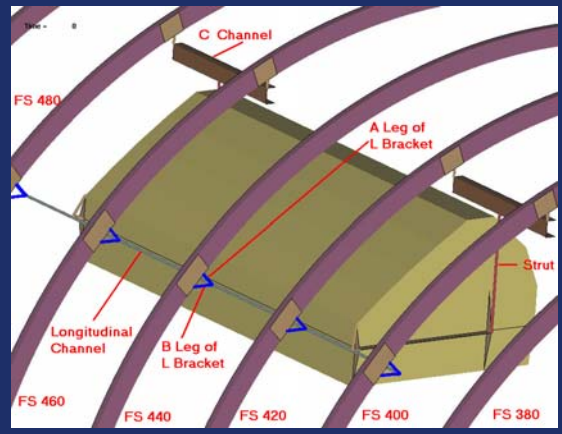
Boeing 707

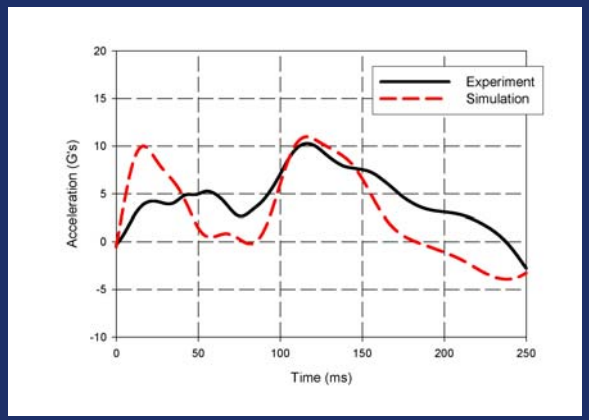
Boeing 737

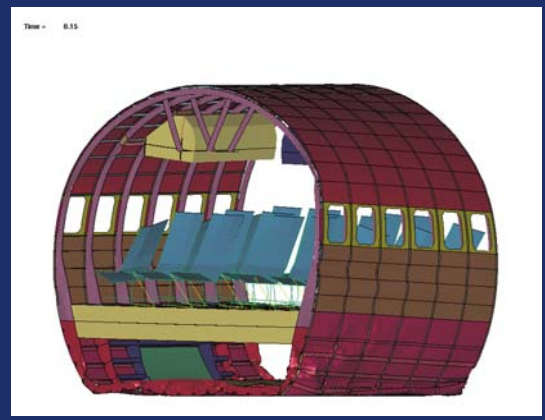
Computer Model



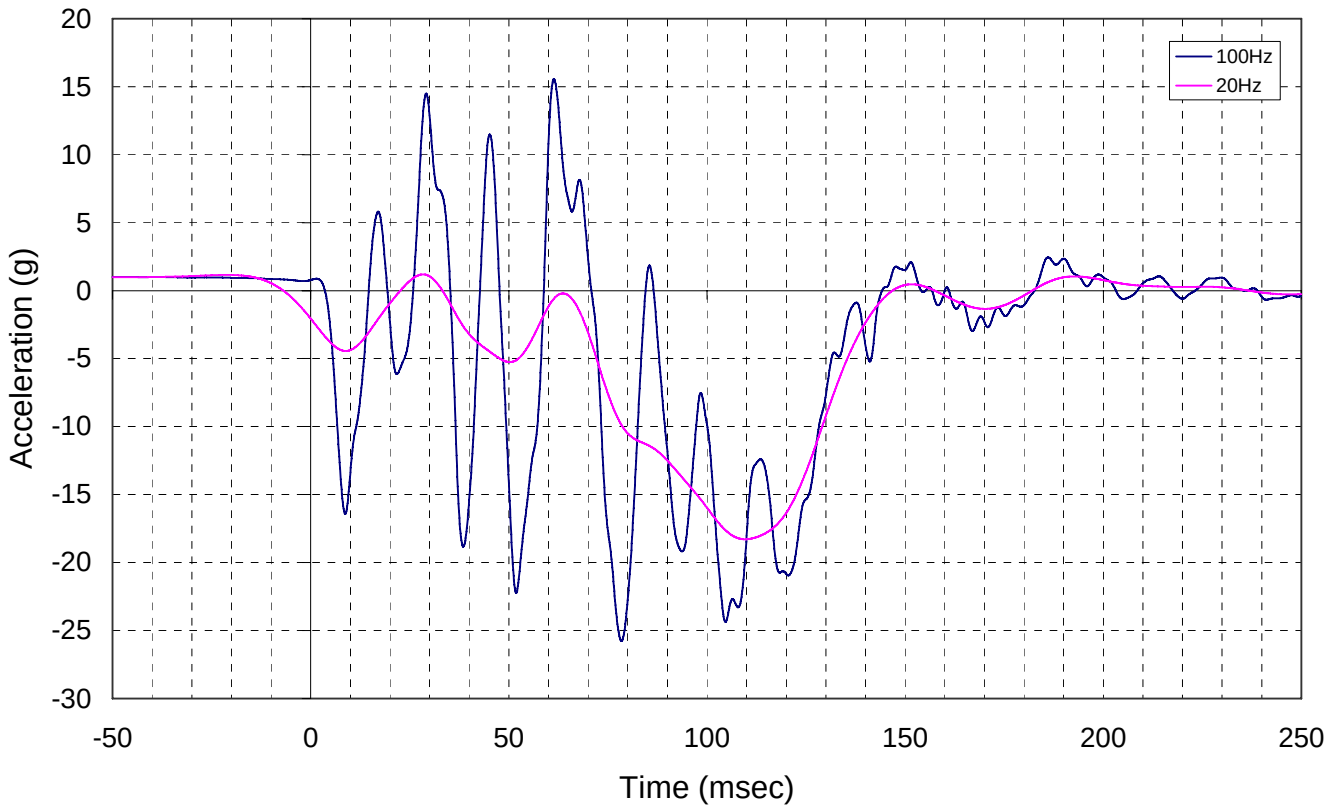








Typical Sidewall Accelerations



Vertical Test Data

Vertical Inertial Acceleration Data

Test	Average Sidewall Peak Acceleration (g)	Average Left-Side Peak Acceleration (g)		Average Right-Side Peak Acceleration (g)	
		*Boeing Bin		C&D Bin	
Boeing 707 100 Hz	36	26		**12	
		Hitco Bin		Heath Tecna Bin	
Boeing 737 100 Hz	32	15		18	
		Test	Model	Test	Model
Boeing 737 20 Hz	20	10	11	11	13

*PSU separated from bin. **Last valid reading prior to bin failure.

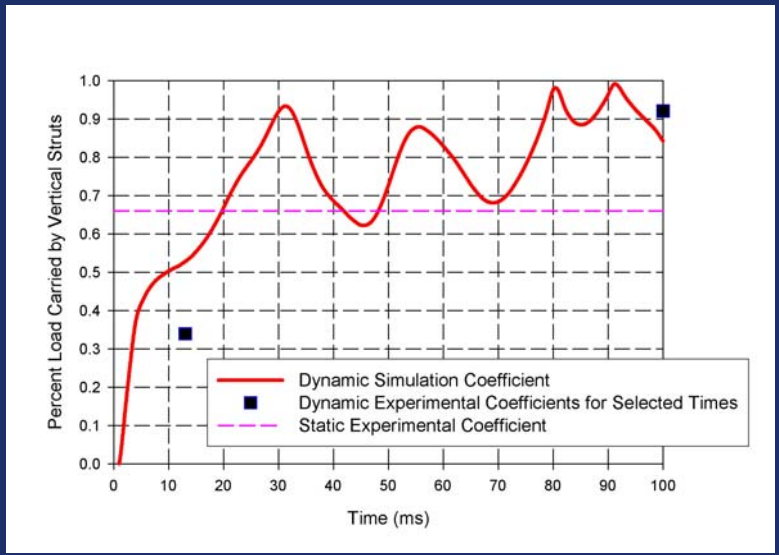
Vertical Results B-737 Test - Hitco Bin

Influence Coefficients

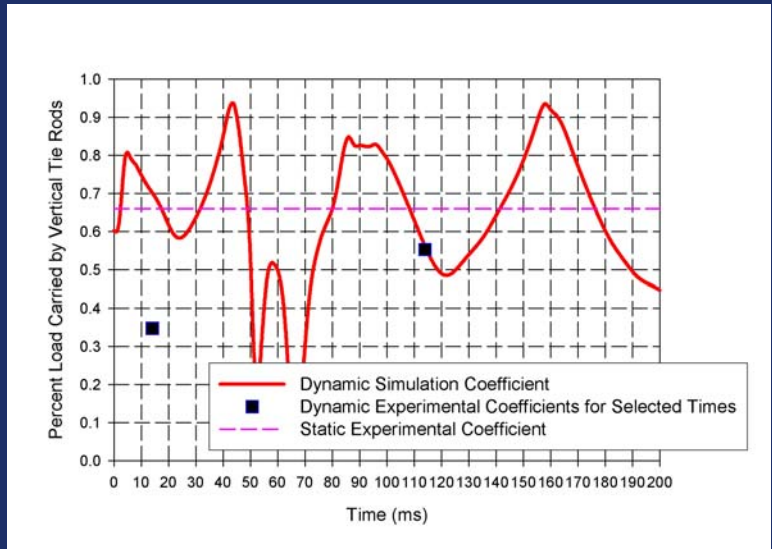
Support Member	Static Equivalent Vertical (z) Load (lb) 6 g	Measured Dynamic Vertical (z) Load (lb) 6 g @ 16 msec	Static Equivalent Vertical (z) Load (lb) 15 g	Maximum Measured Dynamic Vertical (z) Load (lb) 15 g @ 113 msec	Vertical Component Influence Coefficient		
					Static	Dynamic 6 g @16 msec	Dynamic 15 g @ 113 msec
H1	552	313	1291	892	0.358	0.203	0.247
H2	473	321	1107	1130	0.307	0.208	0.313
H3	91	110	213	172	0.059	0.071	0.048
H4	0	6	0	29	0.000	0.004	0.008
H5	163	257	382	464	0.106	0.167	0.129
H6	-3	-4	-7	-11	-0.002	-0.002	-0.003
H7	174	338	408	612	0.113	0.219	0.170
H8	2	-1	4	-12	0.001	0.000	-0.003
H9	99	174	231	293	0.064	0.113	0.081
H10	0	9	0	34	0.000	0.006	0.009
H11	-8	17	-18	3	-0.005	0.011	0.001
Total load	-------	1541	------	3607	-------	-------	-------

Dynamic and Static Influence Coefficients - B-737 Test

Heath Tecna Bin



Hitco Bin



Vertical Test Data

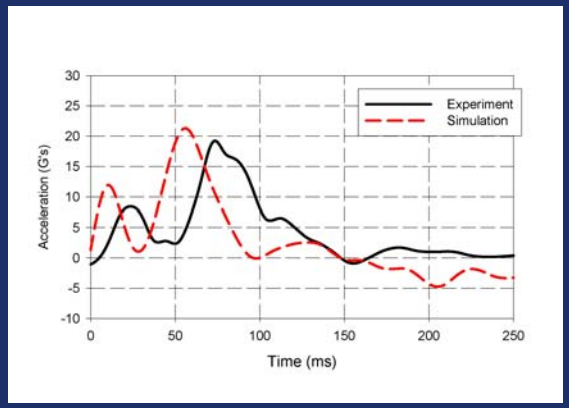
Inertial Acceleration Data

	Maximum Inertial Load		
	X-direction (g)	Y-direction (g)	Z-direction (g)
Boeing 707 Test			
Boeing Bin*	**+16/-20**	+2/**-20**	**+19/-26**
C&D Bin**	+7/**-8**	**+5/-6**	**-12**
Boeing 737 Test			
Hitco Bin***	+7/**-4**	**+11/-14**	**+6/-15**
Heath Tecna Bin	+7/**-6**	**+12/-7**	+2/**-18**

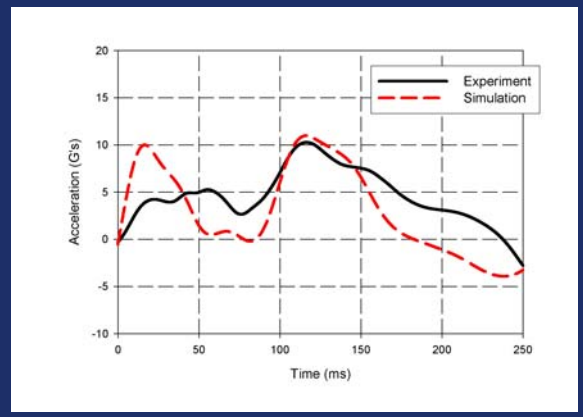
100-Hz data. * PSU came off. **Bin failed after this reading and detached. ***PSU may have detached if not for strap. Bold indicates exceeded current certification requirements. Current bin certification requirements (25.561), X-dir +9/-1.5, y-dir ±3, z-dir -6/+3.

Modeling Results

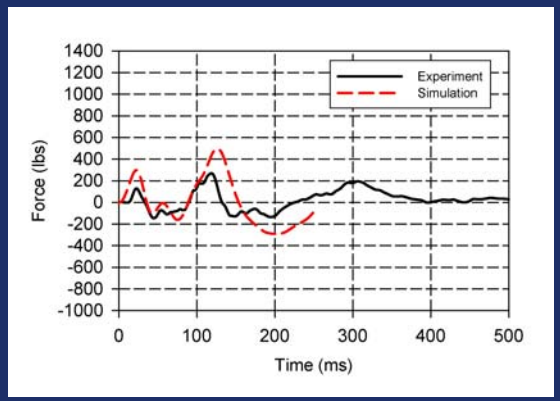
FS 380 Seat Track Acceleration



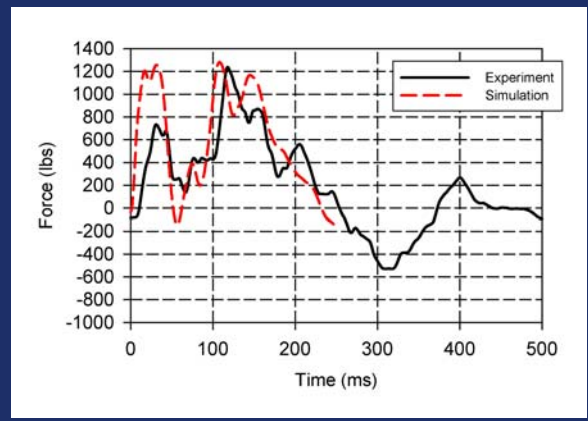
Hitco Bin Average Acceleration



Hitco Bin Horizontal Link



Hitco Bin Load Aft Tie Rod



Results and Conclusions

Longitudinal Simulated Impact Tests

- All the bins passed the static calibration pull test.
- Good agreement between static and dynamic inertial loading.
- Inertial data matched measured strain gage data.
- During the 6-g dynamic test, one bin failed. The bin was modified. All four bins completed the 9-g dynamic test.

- C&D bin detached from fuselage (loading in excess of certification req.) Forward Boeing bin PSU swung open and the aft PSU detached at the front aisle corner (16-g dynamic test).
- Tear out occurring at mounting location of longitudinal drag strut on Boeing bin, required modification (6-g test) . Damage consistent with field reports – resulted in Airworthiness Directive.

Results and Conclusions Cont'd

Vertical Drop Impact Tests

- Bin passed vertical static calibration test
- Dynamic loads exceeded static load requirements.
- Three of the four bins remained attached to fuselage.
- Both PSUs of the Boeing bin detached.
- The front aisle corner of the forward Hitco bin PSU swung down and back up, the other three corners remained attached. The aft PSU was secured by a strap that kept the bin closed.
- Both PSUs of the Heath Techna bin remained attached.
- Dynamic loading varied around static value.

- Static and dynamic loading of brackets differed.

Results and Conclusions Cont'd

Vertical Drop Impact Tests Modeling Results

- Fuselage accelerations were similar.
- Bin accelerations were similar.
- Support bracket loads were similar.

- Greater details required to improve results.


Thank You