IMPACT DYNAMICS INSTRUMENTATION

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CID INSTRUMENTATION

One of the tasks specified in the NASA Langley Controlled Impact Demonstration (CID) work package was to furnish dynamic instrumentation sensors. The types of instrumentation sensors required (figure 1) were accelerometers for aircraft structural loads measurements, seat belt load cells to measure anthropomorphic dummy responses to the aircraft impact, and strain gage bending bridges to measure the aircraft fuselage and wing bending during impact.

1. Accelerometers

2. Seat belt load cells

3. Strain gage bending bridges

Figure 1

OBJECTIVES

The objective in the selection of dynamic instrumentation for the CID was to provide 352 of the highest quality transducers and remain within budget allocation. The transducers that were selected for the CID evaluation process (figure 2) were each subjected to rigorous laboratory acceptance tests and to aircraft fuselage section drop tests at the LaRC Impact Dynamics Research Facility. Data compiled from this series of tests showed the selected transducers to be best suited for the CID mission requirement.

Provide 352 data transducers for CID

1. Select transducers for evaluation

2. Evaluate selected transducers

3. Procure selected transducer on the basis of reliability-availability and costs

Figure 2

CID ACCELEROMETER

The accelerometer found to be best suited in the CID instrumentation application was the Endevco Model 7264200. A synopsis of the transducer specifications is listed in figure 3.

Range:	±200"G"
Overrange:	to ±500"G"
Sensitivity (typ):	2.0 to 2.5 mV/G
Damping ratio:	0.001 (% of critical)
Excitation:	10.00 V DC
Electrical configuration:	1/2 Wheatstone Bridge (2 active arm)

Figure 3

CIO SEAT BELT LOAD CELL

Lap belt load cells used to measure lap belt forces produced at impact by the anthropomorphic dummies were from the LeBow Corporation Model 3419. Pertinent specifications are listed in figure 4.

Range:	3500 lb
Overrange:	8,000 lb
Sensitivity (nom):	±2 mV/Volt
Excitation:	10 V DC
Electrical configuration:	350 Ohm Wheatstone Bridge
Belt thickness (max):	0.1 in.
Belt width (max):	2.0 in.

Figure 4

CID STRAIN GAGES

The strain gage type selected to instrument the aircraft fuselage and wings was the Micro-Measurements Corporation type CEA-13-250-UW-350. Environmental and design characteristics of this gage make it particularly attractive for test applications on aluminum structures. Gage specifications are listed in figure 5.

Gage resistance:	350 Ohms
Gage factor:	2.11 ±0.5%
K_t:	+0.1%
Temp compensation:	Self compensating
Strain limits:	30 to 50 K micro-strain (tension or compressison)
Tested on:	2024-T4 aluminum

Figure 5

CID ACCELEROMETER CONSTRUCTION

The diagram of the 7264 accelerometer (figure 6) shows the two solid-state silicone resistors that form the active elements of the transducer. The cantilevering action of the beam causes the silicone elements to vary in resistance, thereby unbalancing the bridge to produce an electrical output.

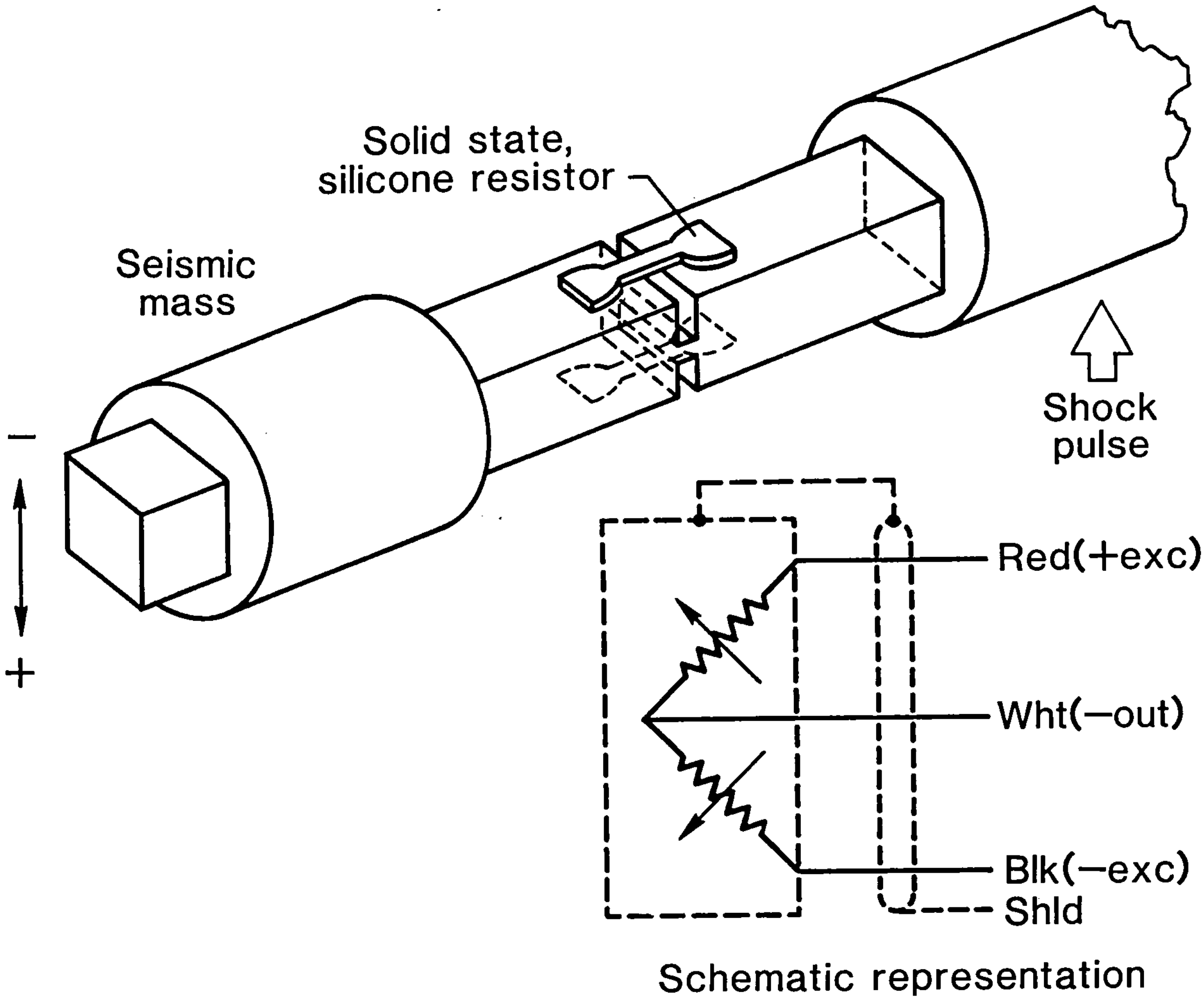

Figure 6

CID TRANSDUCER WIRING

The accelerometer plug wiring shown in figure 7 was typical of all transducers aboard the CID. All transducers being resistive bridge element type were wired in identical fashion to facilitate transducer interchange and simplify data records. Note that the accelerometer bridge completion resistors were installed in the sensor plug such that the entire bridge would be subjected to the same environmental variations.

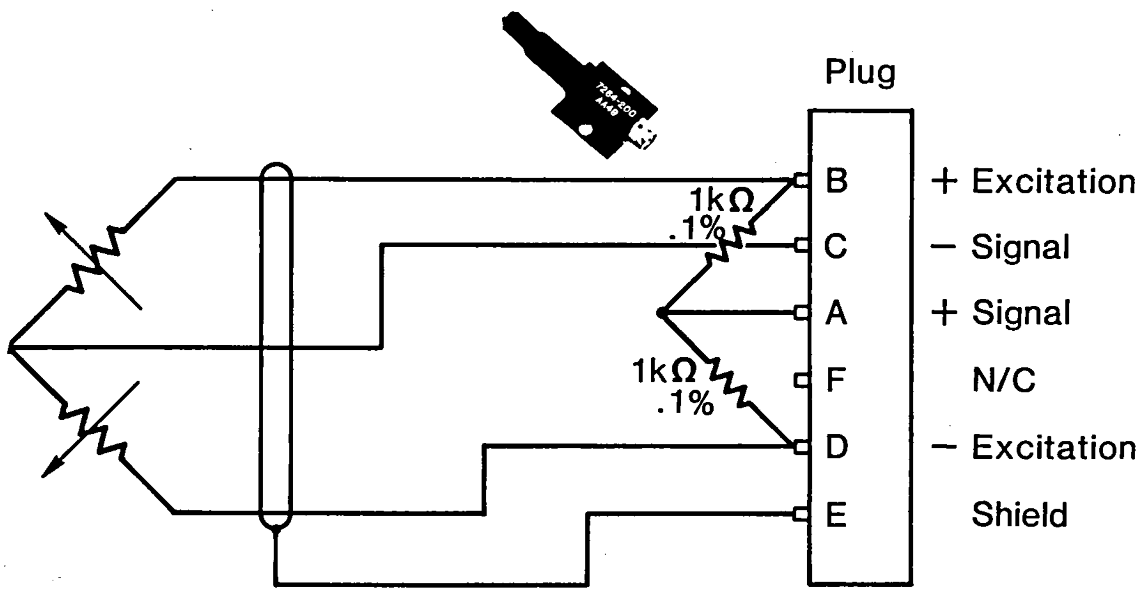

Figure 7

CID ACCELEROMETER MOUNTING

To achieve sameness with respect to specified transducer locations on the CID airframe, a one-inch cube aluminum block (figure 8) was used. This allowed all transducers in bi-axial or tri-axial clusters to measure the impact shock pulses at exactly the same airframe location thereby simplifying the task of data reduction. Scotchweld 2216 epoxy was used to affix the accelerometers and/or blocks to the airframe.

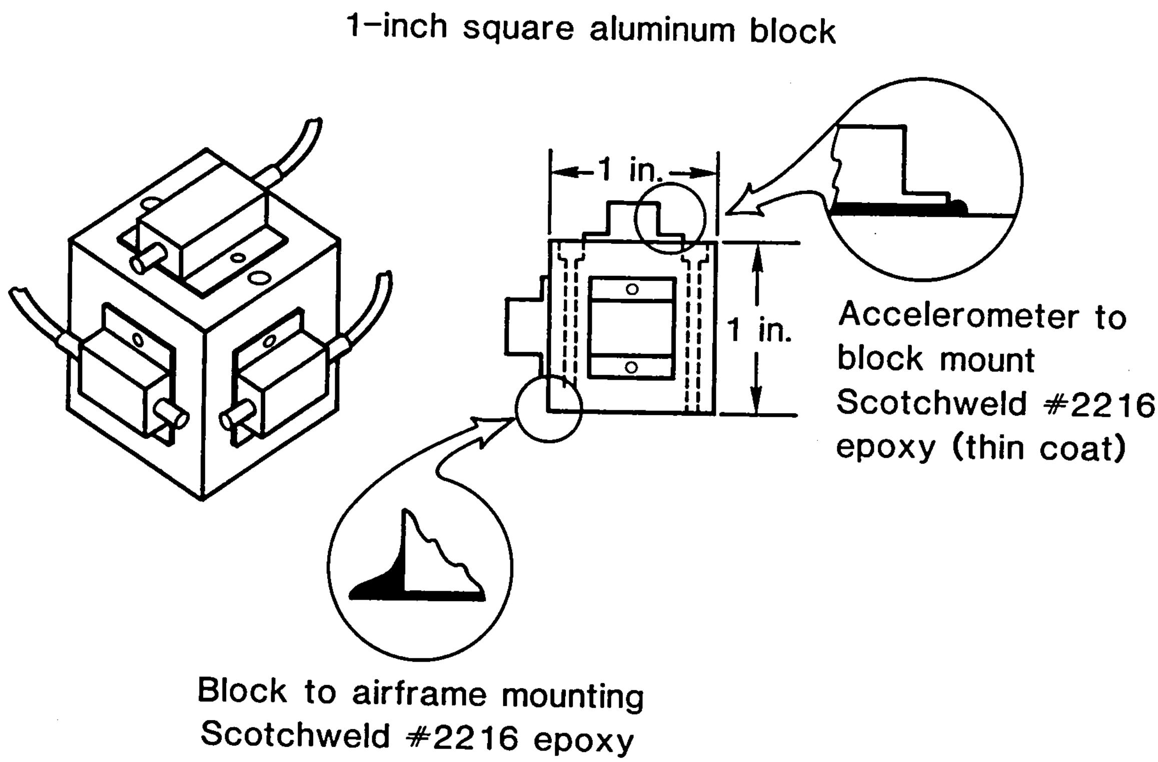

Figure 8

CID FUSELAGE CROSS SECTION
-ACCELEROMETERS-

The illustration in figure 9 depicts a typical CID aircraft fuselage ring section fully instrumented with accelerometers. Accelerometers mounted across the floor beam were used to measure the impact shock pulse input to the passenger seats.

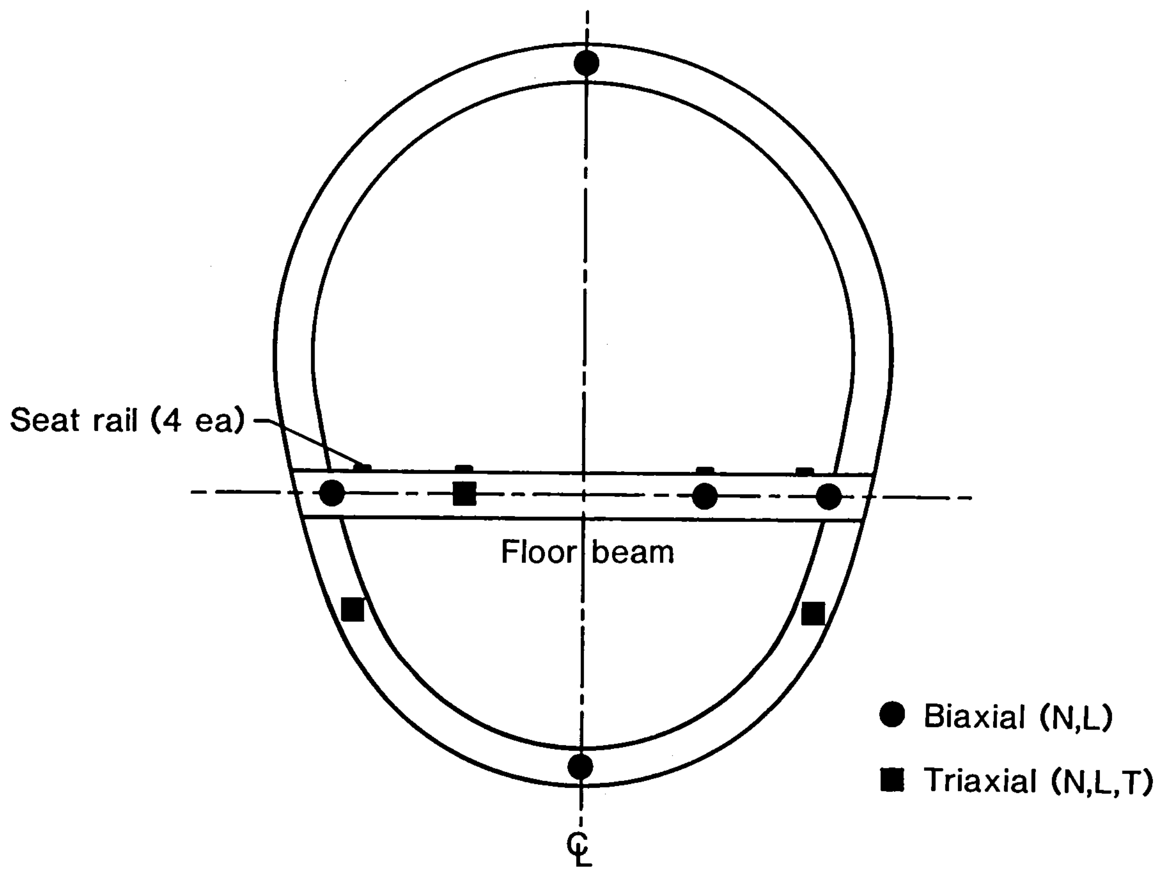

Figure 9

CID BENDING BRIDGES

The strain gage bridge representation of figure 10 describes the tension/compression configuration of the CID fuselage and wing bending bridges. This bridge gage arrangement increases the total milli-volts/volt output of the bridge by a factor of four over a single active gage bridge. Note that the connector plug wiring is compatible to that of the accelerometers wiring.

Gage type CEA-13-250-UW-350

Bending bridges - 4 active arm

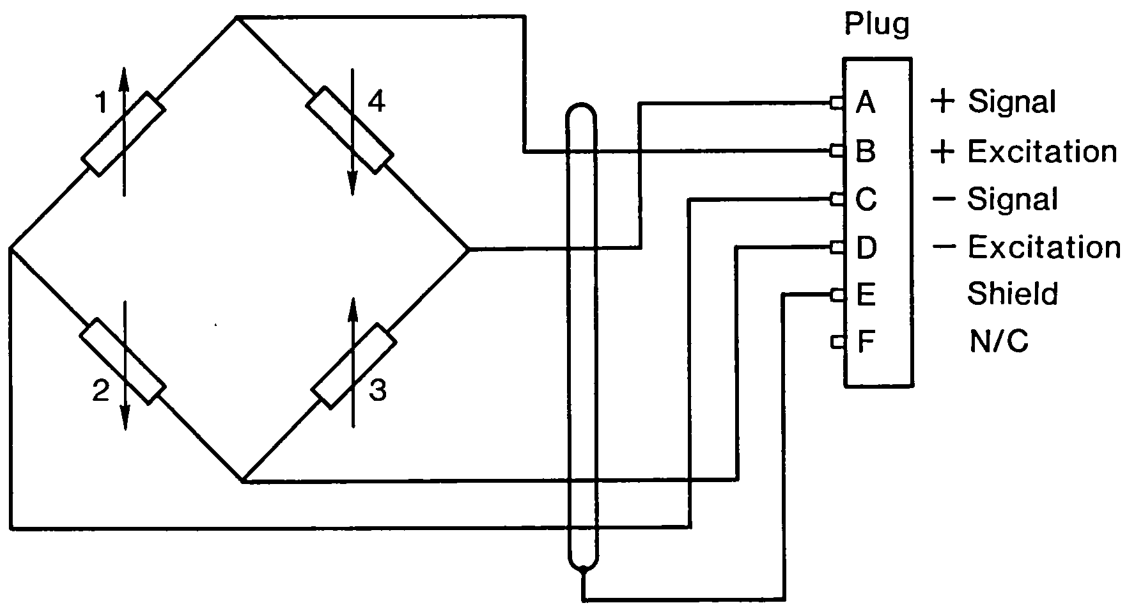

Figure 10

CID FUSELAGE CROSS SECTION
-BENDING BRIDGES-

The illustration in figure 11 depicts a typical aircraft fuselage ring section fully instrumented with strain gages. Each bending bridge location was instrumented with a primary and backup (spare) bridge. The strain gages were bonded to the structure with 610 adhesive and a weather coating applied to environmentally protect each gage.

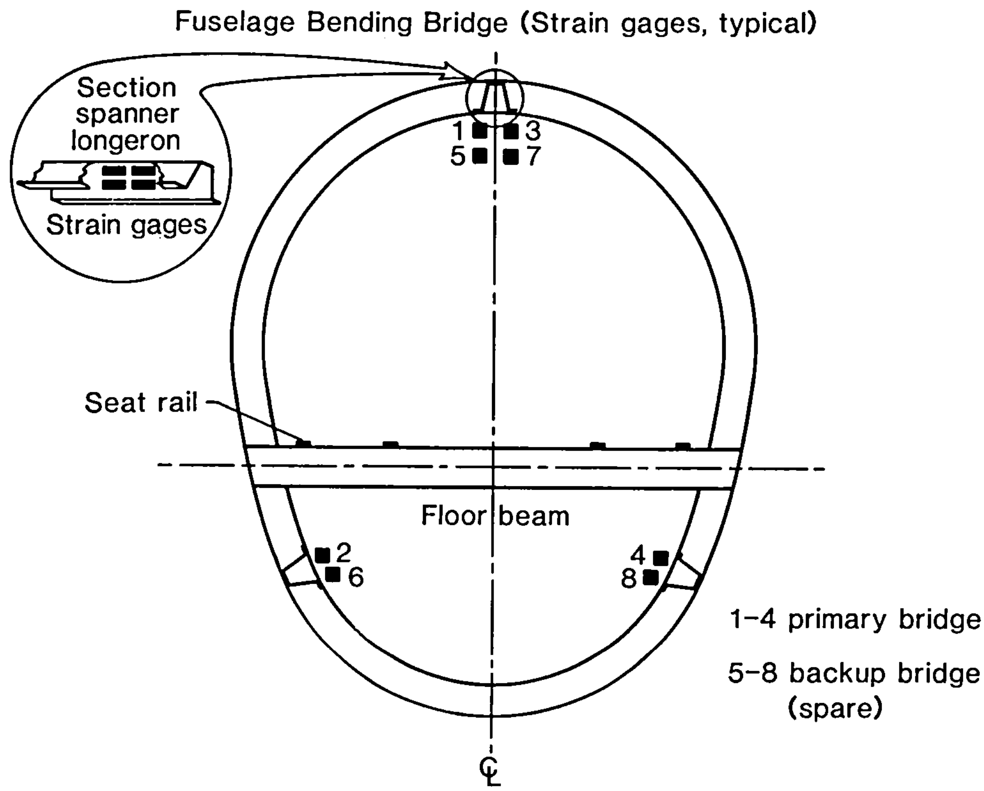

Figure 11

SUMMARY

1) The transducers installation technique on the airframe proved successful.
2) The transducer quality assurance was guaranteed through rigorous acceptance testing.
3) Data acquired was 97.0%.