



ASSESSMENT OF THE ISO IMPACT DAMPING TEST FOR WHEELCHAIR CUSHIONS

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ABSTRACT

The ISO 16840-2 impact damping test characterizes wheelchair cushion abilities to reduce impact loading on tissues and to help maintain postural stability. Impact loading can occur during activities of daily living such as rolling off a curb.

Objectives

- Improve the methodology described in the ISO standard
- Determine the repeatability of the accelerations resulting from the ISO test method
- Assess the test method's ability to distinguish the impact damping performance of different cushions

Methods

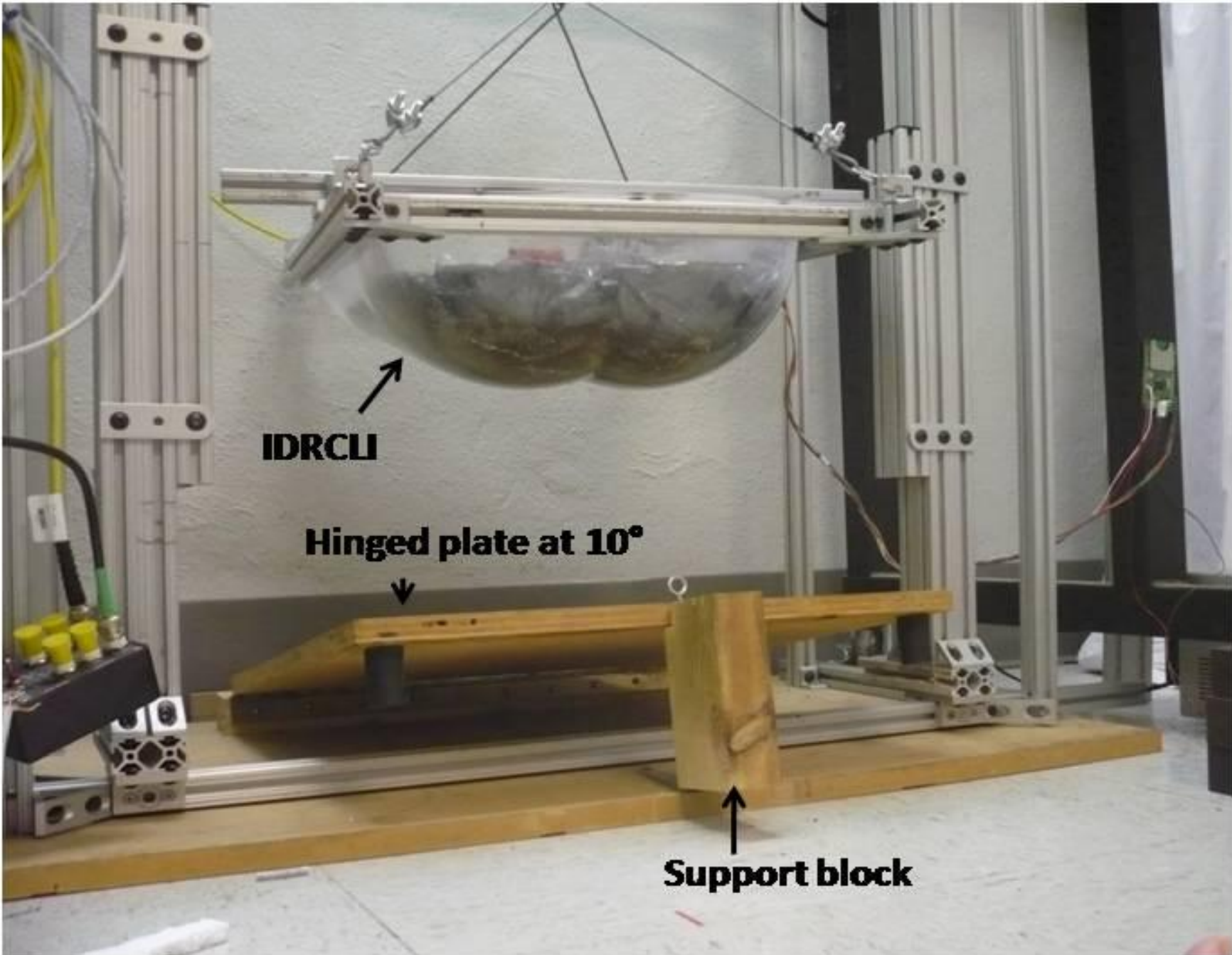
Experimental Protocol

1. Test procedures performed after ISO 16840-2, chapter 11.2 on 5 cushions using a modified testing rig
2. Three operators tested all cushions on 3 different days
3. Each cushion was tested 6 times per day for a total of 18 tests per cushion

Cushion cohort

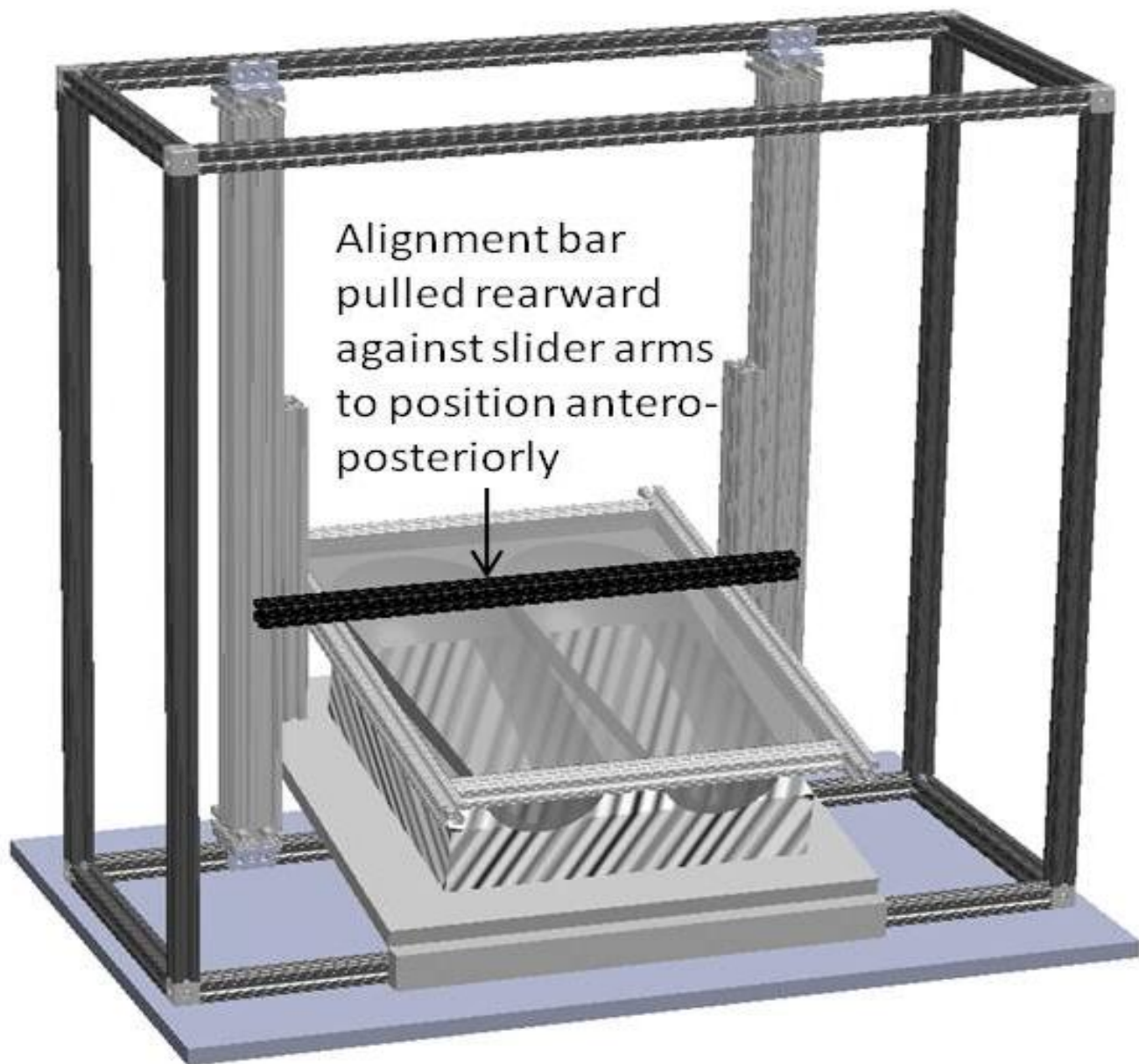
Cushion	Manufacturer	Material
3" flat HR 45 Foam #1	Hibco Plastics, Inc; Yadkinville, NC	Urethane foam with 45 IFD
3" flat HR 45 Foam #2	Hibco Plastics, Inc; Yadkinville, NC	Urethane foam with 45 IFD
Cloud	Otto Bock USA, Minneapolis, MN	Viscous fluid bladders within elastic foam base
Dream	Allegro Medical, Meza, AZ	Viscoelastic foam
Roho HP	The Roho Group, Belleville, IL	Single valve adjustable air cushion

Cushion loading indenter & Support system

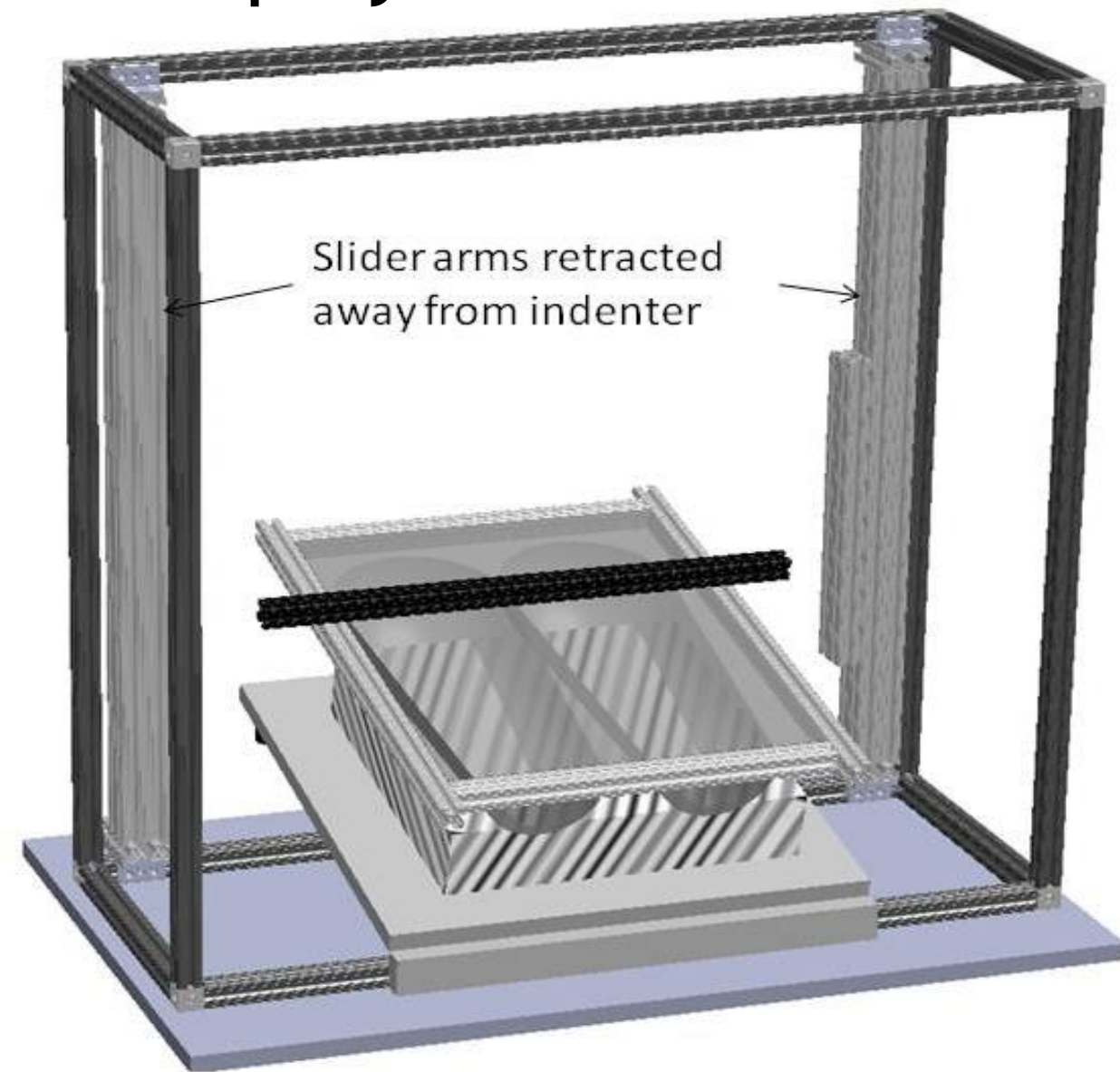


Modifications

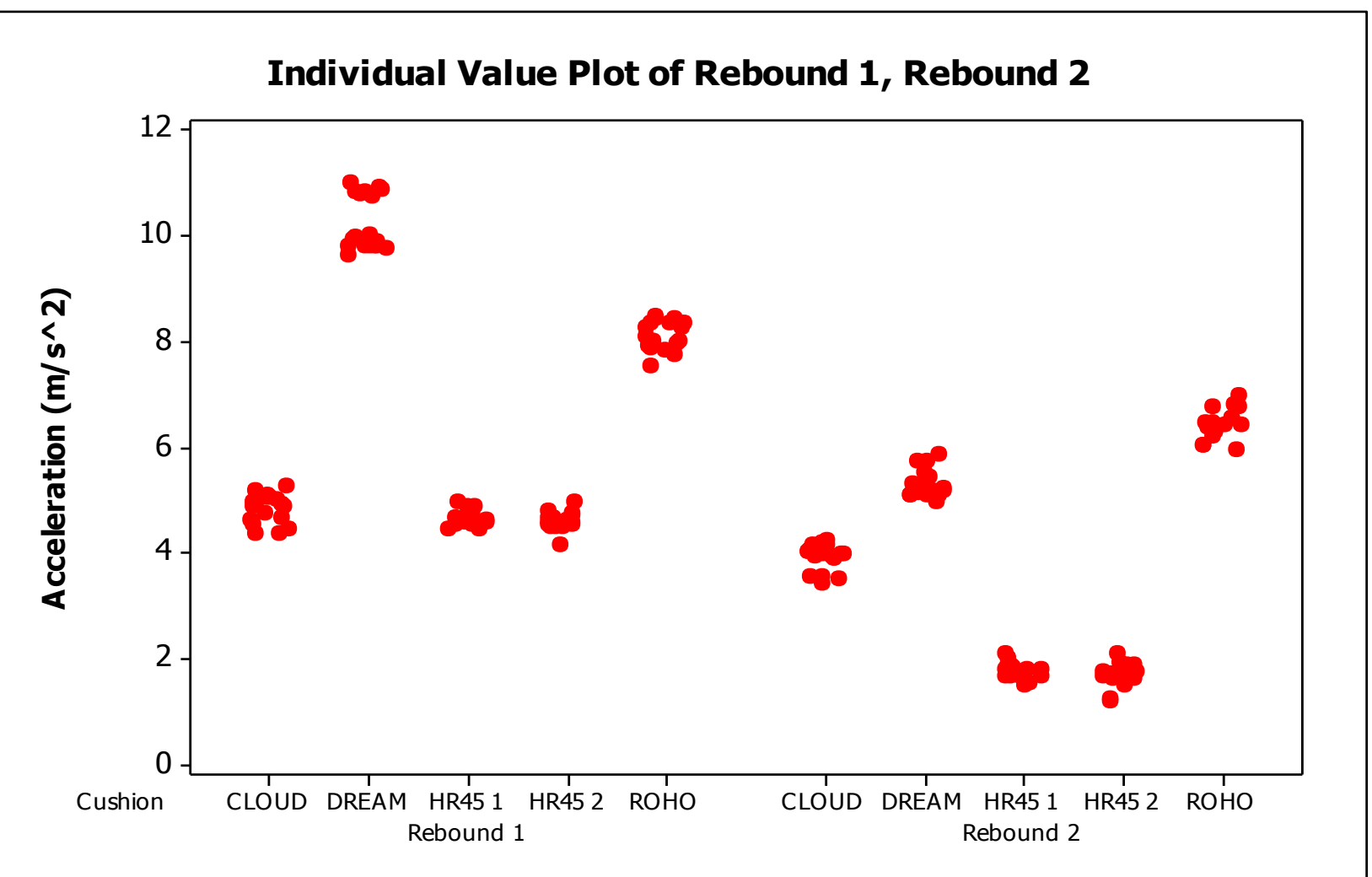
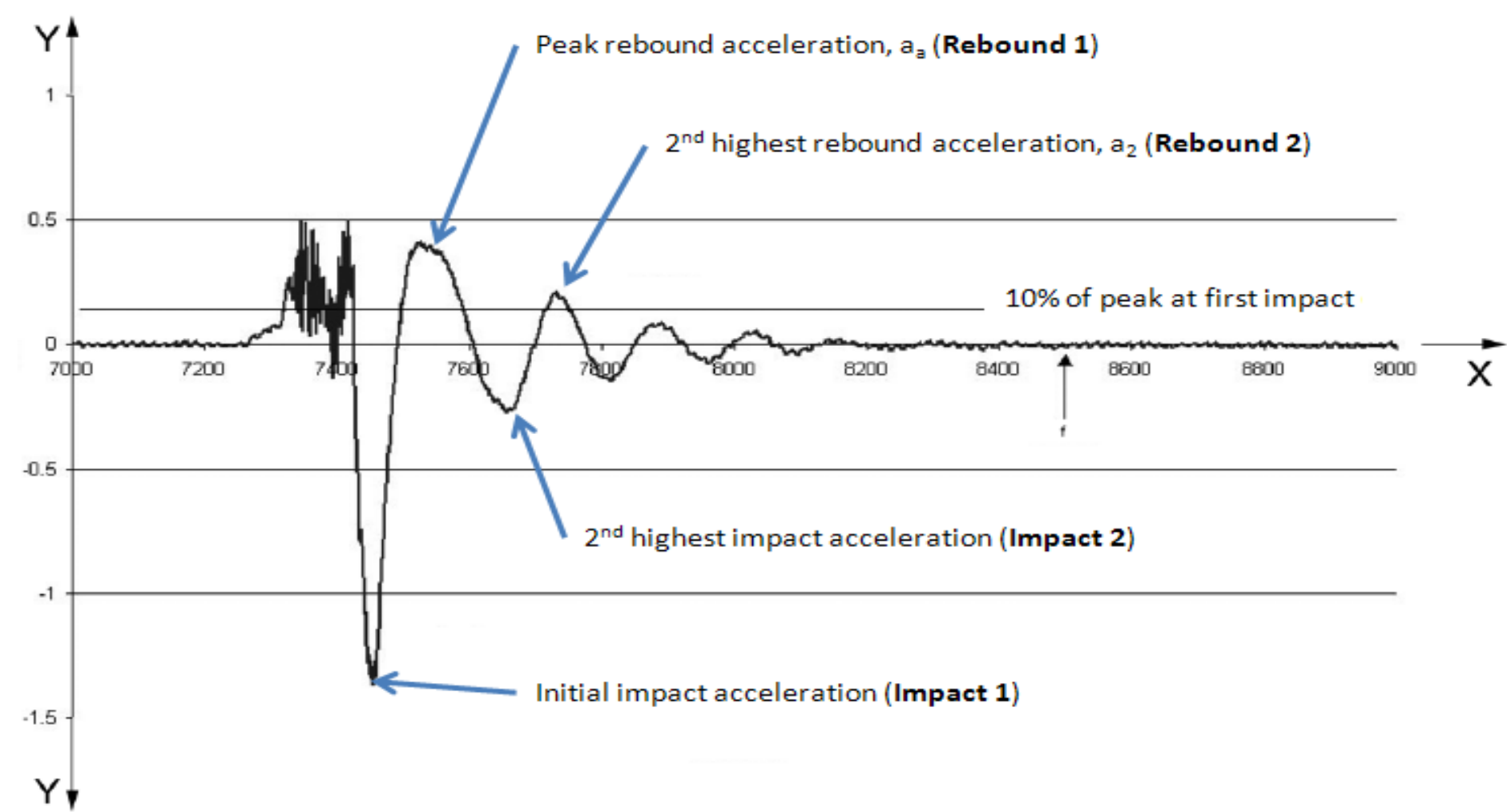
Slider arms engaging the indenter to insure proper alignment



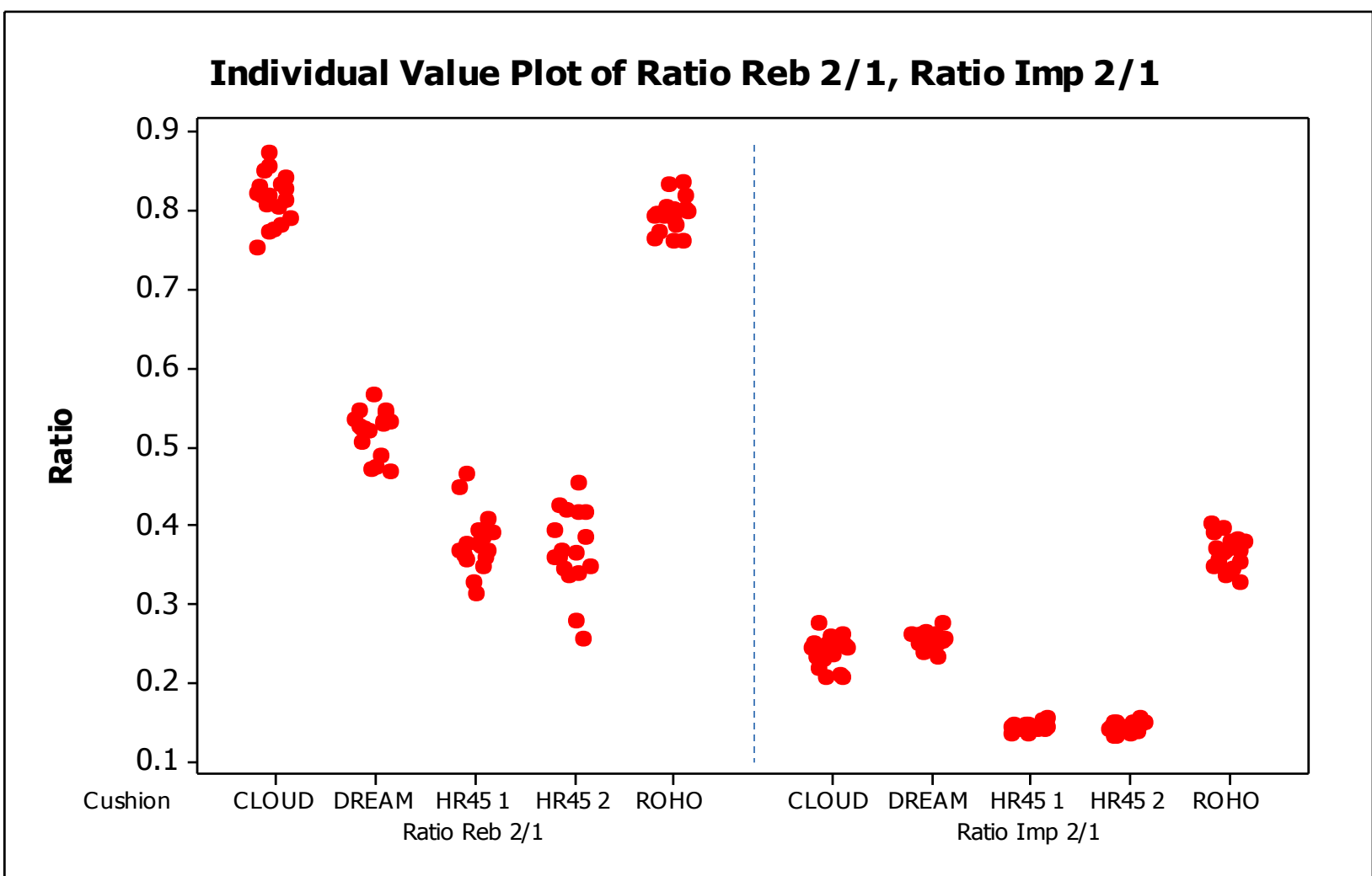
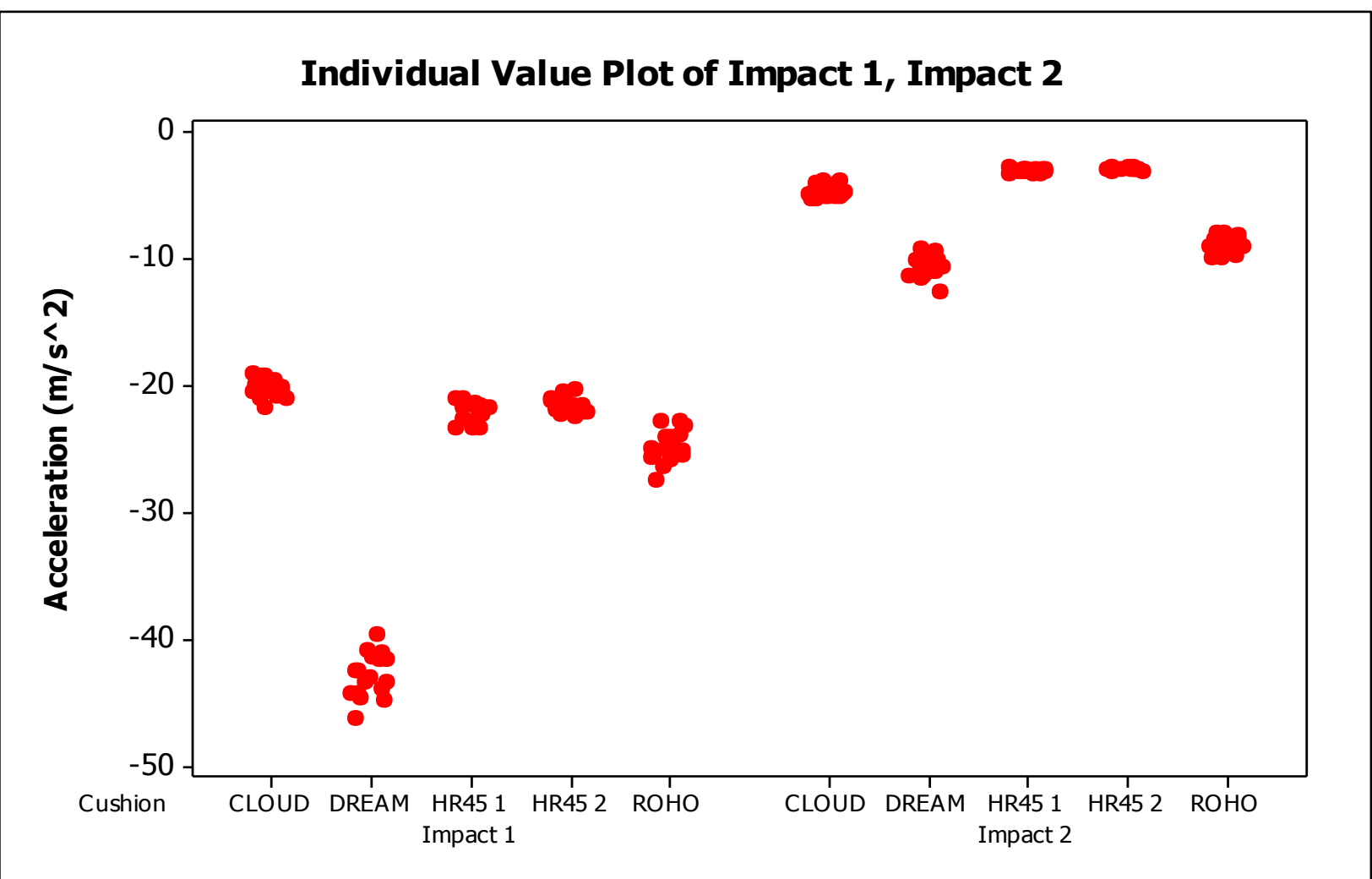
Slider arms retracted prior to test deployment



Results & Discussion



Cushion Test Results



ISO defined variables

- Mean number of rebounds >10% of peak acceleration
- Magnitude of Rebound 1
- Magnitude of Rebound 2
- Ratio of Rebound 2 to Rebound 1

Additional variables

- Magnitude of the acceleration at initial impact (Impact 1)
- Magnitude of the acceleration at 2nd impact (Impact 2)
- Ratio of Impact 2 to Impact 1

Data Analysis

- A single-factor analysis of variance (ANOVA) using initial impact and the two acceleration ratios was performed to determine the test's ability to distinguish products based upon the acceleration responses.
- A Gage Repeatability & Reproducibility (Gage R&R) analysis was performed to evaluate test procedures by assigning variability due to the measurement system, cushions and testing days

ANOVA Results

Initial Impact: differed across cushions (p<0.001)	Two HR45 foam cushions were not different from each other All cushion types were significantly different from each other
Rebound 2 to Rebound 1 Ratio: differed across cushions (p<0.001)	Two HR45 foam cushions were not different from each other Roho High Profile and Cloud were not different from each other All other comparisons were significantly different from each other
Impact 2 to Impact 1 Ratio: differed across cushions (p<0.001)	Two HR45 foam cushions were not different from each other Dream and Cloud were not different from each other All other comparisons were significantly different from each other

Conclusion

- The ISO test method using a modified test apparatus was reliable and was able to distinguish performance across a small cohort of cushions.
- Suggested changes to the ISO test method include:
 1. Defining an explicit distance from an accelerometer to the axis of rotation
 2. Dictating that the test rig use a mechanism that insures a fixed distance between the accelerometer and the axis of rotation
 3. Acceleration magnitude at initial impact and the ratio of the 1st and 2nd impacts should be reported as results of this test.

Gage R&R of Parts and Days Analysis

Source	Impact 1 (% Contribution of Overall Variance)	Rebound Ratio (% Contribution of Overall Variance)	Impact Ratio (% Contribution of Overall Variance)
Total Gage R&R	1.13	2.32	2.74
Repeatability (equipment)	1.13	2.32	2.74
Reproducibility (testing day)	0.00	0.00	0.00
Part-To-Part (cushion to cushion)	98.87	97.68	97.26
Total Variation	100.00	100.00	100.00

Acknowledgement

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