MEDITEC
ENHANCING PATIENT CARE

MEDITEC GEL CUSHION

Standard HR70 Reference
Evaluation of Wheelchair Seat Cushions

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HOW TO USE THIS REPORT

The performance of a wheelchair cushion is a combination of many different parameters, and no single one stands out as being the most important. Different users will have different prime purposes for their respective cushions, and this means that different criteria will apply.

The purpose of these reports is to provide authoritative and accurate information as to the performance of cushions against a variety of objectively measurable criteria. The user, carer, or prescriber can then use this information to make informed choices based on those criteria deemed to be most important for a specific user.

It must be acknowledged that the information contained in these reports is not exhaustive, and must be used alongside clinical judgment and common sense.

When choosing and using a wheelchair cushion, do not rely solely on the contents of these reports, but play close attention to the correct set-up of system comprising both wheelchair and cushion.

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DEVELOPMENT OF TEST CRITERIA

The test criteria presented here are the result of many years development and discussion. Much of this process has been undertaken under the auspices of the International Standards Organisation (ISO) Working Group 11 (ISO TC 173/SC 1/WG 11), charged with the development of international standards for wheelchair seating.

This process has engaged with physiotherapists, occupational therapists, physicians, engineers, nurses, carers, and users internationally. Points have been initially debated by internet forum, and later proposed and voted at a succession of international meetings. This has ensured a very broad base of consensus for the evaluation criteria, and the test methods employed.

The methods employed in these reports do not currently constitute an International Standard. Draft standards for discussion have been circulated[1], and it is anticipated that further adjustments may be made in due course before final decisions are reached. These methods are, however, the current state of the art in the standards development process.

Validation of these test methods has been undertaken by inter-laboratory comparison in 3 different countries to ensure robustly reproducible results.

[1] **ISO/DIS 16840-2 Test** methods for determining the physical and mechanical characteristics of devices intended to manage tissue integrity –Part 2: Seat Cushions.

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RATIONALE AND METHODS

All the test criteria and methods employed are described below.

1 Horizontal Stability

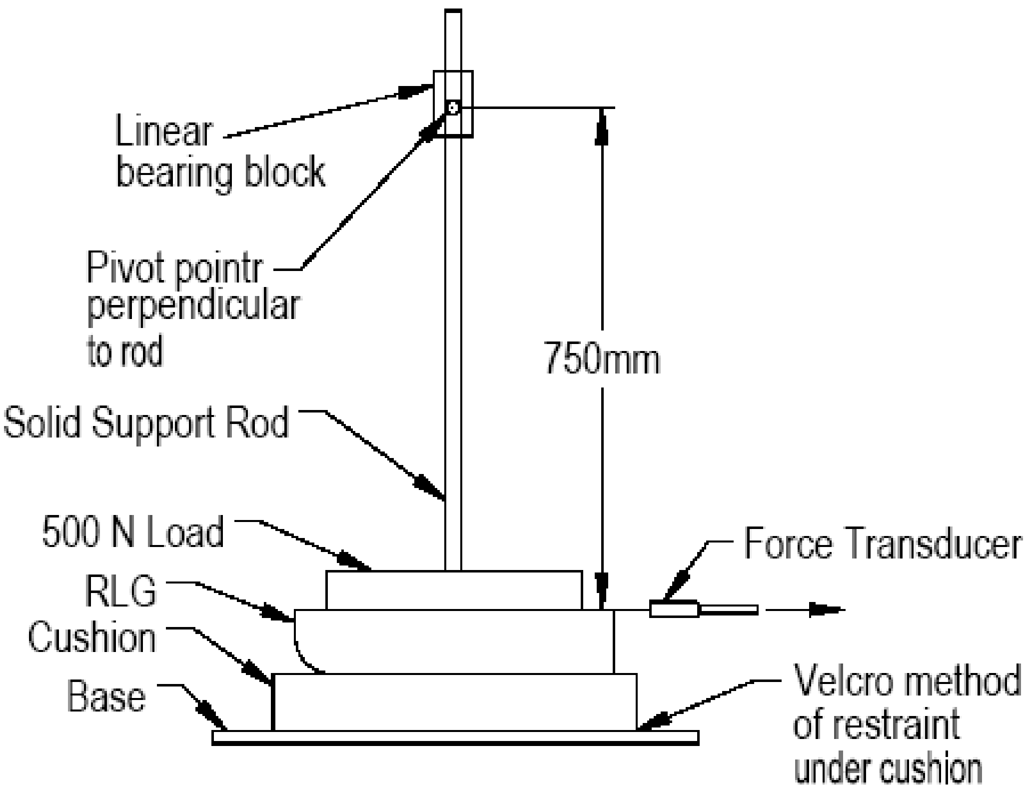

Figure 1: Apparatus for measuring horizontal stability parameters

The apparatus shown in figure 1 comprises a rigid base, nominally shaped to represent a person's bottom, attached to a linear guide, which is pivoted at the top. This allows a weight of 50kg to be loaded onto the base, representing the seated weight on the cushion. This assembly can then be pulled forward by means of a cable attached to a force gauge. 2 features of the cushion's performance can be measured in this way:

Horizontal Stiffness

Forces tangential to the surface of the skin (“shear forces”) are known to contribute to skin damage. These forces may arise as a result of small body movements, with relative movement between adjacent areas of skin. Deformability of the cushion surface in a direction tangential to the skin can accommodate these small movements, and so reduce the associated forces.

Horizontal stiffness is measured by recording the force at which the loading apparatus moves forward by 5mm, without slipping on the surface of the cushion. This procedure is repeated to a total of 3 times, and the mean value is presented together with the standard deviation.

Report output:

Horizontal Stiffness (N)
average of 3 (+/- standard deviation)

Lower Horizontal Stiffness => Lower shear forces

Sliding Resistance

For many users, an important consideration is the tendency to slide forwards out of the wheelchair. Safety and stability demand that adequate resistance to sliding is provided by the cushion, appropriate to the user. This parameter combines the effects of the geometry of the cushion (inclines, wedges, and pommels all tend to prevent forward sliding) with envelopment effects (sinking further into the cushion will tend to stabilize), and frictional properties of the cover.

Sliding resistance is measured by recording the force at which the loading apparatus starts to slip relative to the surface of the cushion. This procedure is repeated to a total of 3 times, and the mean value is presented together with the standard deviation.

Report output:

Sliding Resistance (N)
average of 3 (+/- standard deviation)

Higher Sliding Resistance => Improved Stability

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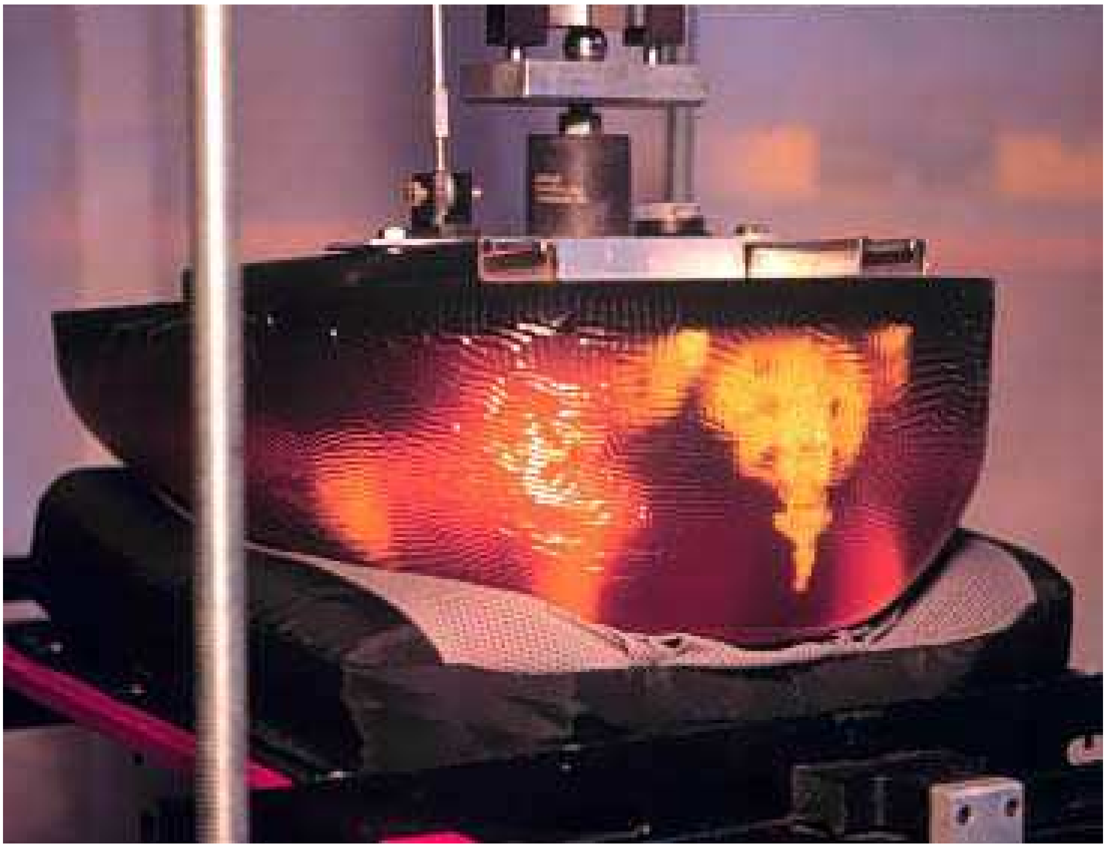
2 Pressure Distribution

For users at risk of pressure ulcers, pressure distribution is an important consideration. The ideal pressure distribution, from a tissue integrity standpoint, spreads the pressures as evenly as possible over the largest possible surface area, to reduce the highest pressure values.

Figure 2a: Pressure distribution apparatus



The apparatus shown in figure 2a consists of a rigid pelvis embedded in a polymer gel material. The total pelvis is loaded to 50k on a standard horizontal rigid wheelchair seat. A pressure-mapping array (XSensor) is placed on the cushion, and the apparatus is loaded onto the cushion. The pressure mapping array flexible, which allows for mapping on deep-contoured cushions without being subject to excessive errors caused by tension in the substrate.

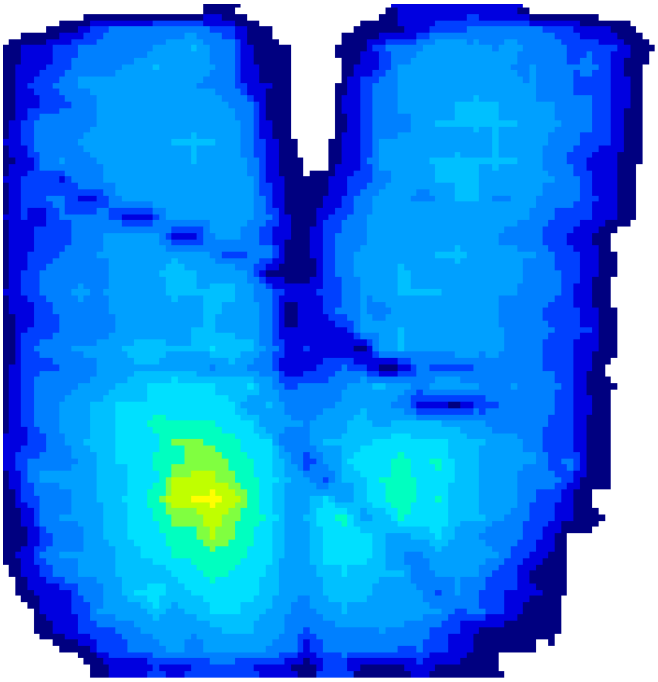


Figure 2b: Sample pressure map

For each pressure map (see figure 2b) , 2 criteria are identified:

Peak Pressure
This represents the highest value of pressure encountered by any 2x2 square of pressure sensors within the map. High pressures have been positively associated with pressure ulcers.

Report output:

Peak Pressure (mmHg)
Average of 3 (+/- standard deviation)

Lower Peak Pressure => Improved Tissue Integrity

Contact area
A higher contact area may indicate better envelopment of the bottom shape by the cushion, and provide for more optimal pressure distribution.

These measurement is made 3 times for each cushion.

Report output:

Contact Area (cm^2)
Average of 3 (+/- standard deviation)

Higher Contact Area => Improved Tissue Integrity

3 Skin Microclimate

The temperature and humidity of the microclimate immediately above a cushion are considered to have an important effect on tissue integrity of the sitter and are strongly influenced by the thermodynamic and moisture dissipating characteristics of the cushion. This method outlines the principles addressed in the simultaneous measurement of the heat and water vapour dissipating properties of wheelchair cushions under test conditions that simulate body loading on support surfaces with flat and contoured profiles.

The apparatus shown in figure 3 has the capacity to supply, measure and control an environment at a temperature and humidity comparable to that generated by the human body sitting on a seat cushion.

It comprises a perforated outer shell formed from 4mm +/- 1 mm polycarbonate sheet formed to a shape nominally representing a human bottom, as specified in DIS ISO 16840-Part 2. An inner reservoir tank is filled with spherical glass flow dispersers (marbles). A microporous water vapour permeable membrane ($5l/24hour/m^2$) lines the inside of the outer shell. A capillary mat, shaped to conform, distributes moisture within the shell

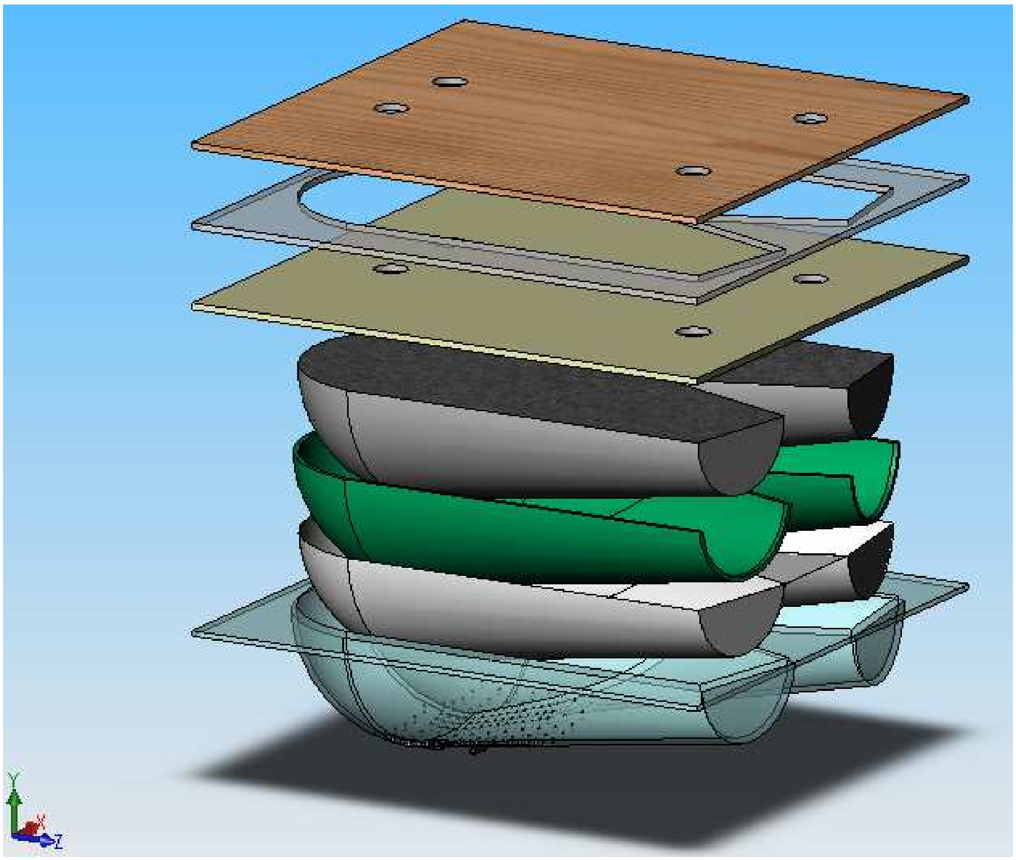


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Figure 3a. Thermodynamic rigid cushion loading indentor (TRCLI). Component parts

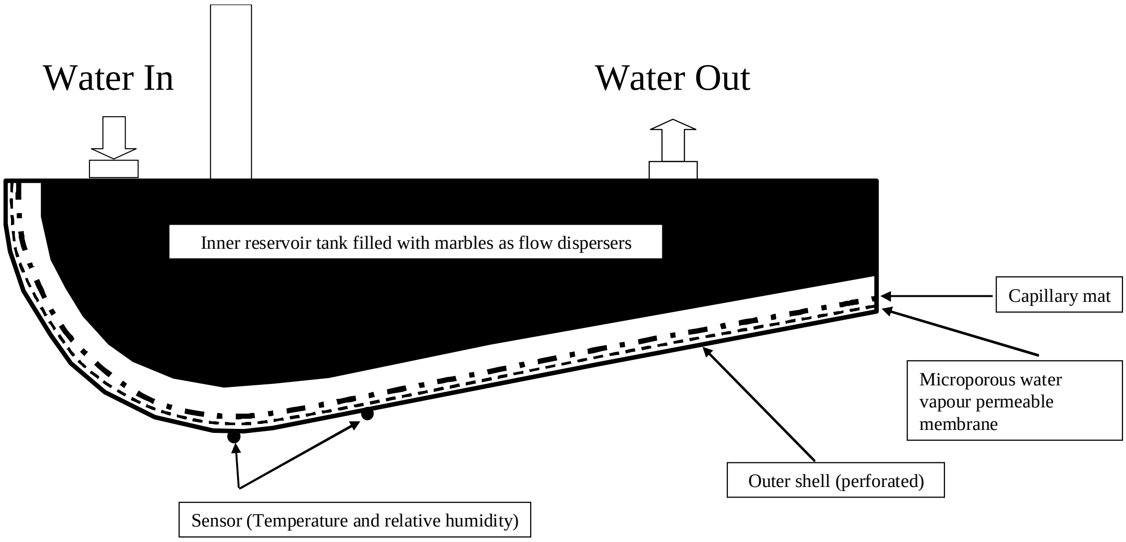

Figure 3b. Thermodynamic rigid cushion loading indentor (TRCLI). Assembled

Sensors to measure temperature and humidity at the interface are placed at the locations of the two ischial tuberosities and 2 proximal thighs (Figure 3).

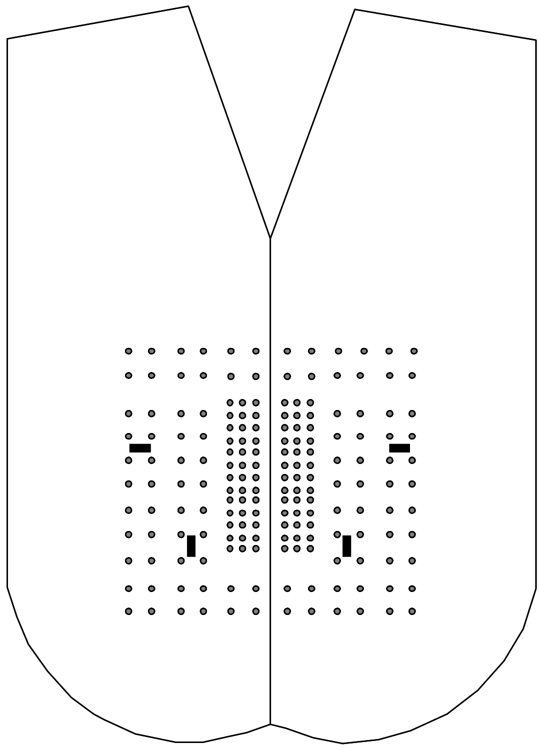

Figure 3. Location of sensors and perforations in outer shell

The apparatus is loaded onto the cushion, and interface parameters (temperature and humidity) are measured over time. Both values generally start low, as the cushion has been stored at room temperature and humidity, and then rise over time. It takes many hours to reach a stable condition. Average values for temperature and humidity after 1 hour at the 4 locations shown are calculated.

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Report output:

Temperature after 1 hour (°C)

Lower Temperature => Improved Tissue Integrity

Report output:

Relative Humidity after 1 hour (%)

Lower Humidity => Improved Tissue Integrity

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4 Loaded Contour

For many users, it is important for a cushion to envelop the bony shapes of the pelvis, without causing “bottoming” (total penetration through the cushion to the base beneath). It is important for the user to maintain a margin of safety in cushioning effect before an overload condition is experienced. Certain functional movements such as leaning and reaching effectively overload an

The apparatus shown in figure 4 consists of a pair of cylinders nominally representing ischial tuberosities, and a wider-set pair of smaller cylinders nominally representing greater trochanters. Tissue covering over these prominences is nominally represented by a strip of webbing material laid over the cylinders.

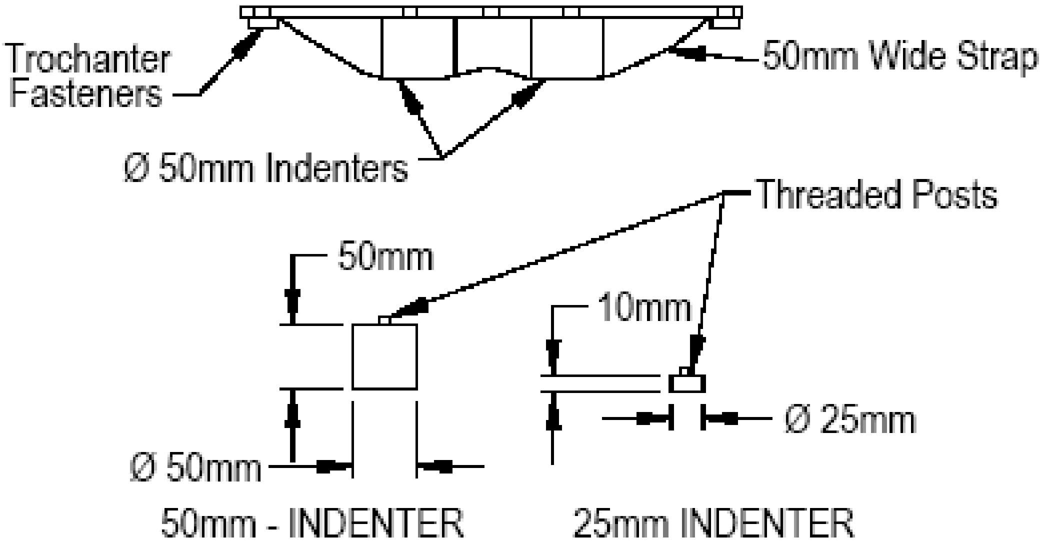

Figure 4 Loaded Contour apparatus

2 parameters are measured:

Contour Depth

The apparatus shown is applied to the cushion, and loaded to 135N. The depth of penetration into the cushion beyond the initial thickness of the cushion is measured. This takes into account the initial contour of the cushion to accommodate the pelvis, as well as the additional contouring due to loading.

Overload Depth

The apparatus is further loaded to 180N, and the additional penetration into the cushion is recorded. This shows the cushion's ability to withstand over-load conditions. If a cushion has already overloaded at 135N, little additional penetration will be seen at 180N.

It should be noted that the indentor shape specified is a 2-dimensional cross-section of a pelvis, and therefore does not model the behaviour of a cushion when the whole surface is loaded. This means that the results of this test must be viewed with caution when considering air-filled or gel-filled cushions.

Report output:

Contour Depth (mm)

Higher Contour Depth => Better Pelvis Envelopment

Report output:

Overload Depth (mm)

Higher Overload Depth => Better Overload Capacity

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5 Weight

Many users remove the cushion from their wheelchairs during transport. This may be to allow folding of the wheelchair, for example. It is therefore more convenient for some to have a lightweight cushion.

Report output:

Weight (kg)

Lighter Weight => Easier Lifting and Handling

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6 Impact damping.

Wheelchairs are used dynamically, and the cushion properties have a large influence on the smoothness of ride over rough terrain, or going over kerbs. The apparatus shown in figure 6 consists of a rigid indenter, nominally representing a human bottom, and weighing 50 kg. The indenter is hinged at the back, and initially elevated 5°, to a height nominally repre senting a kerb. An accelerometer is attached to the top of the indenter, to record acceleration. A cushion is placed underneath the indenter. At a designated moment, the support block holding up the indenter is retracted, allowing the indenter to fall onto the cushion.

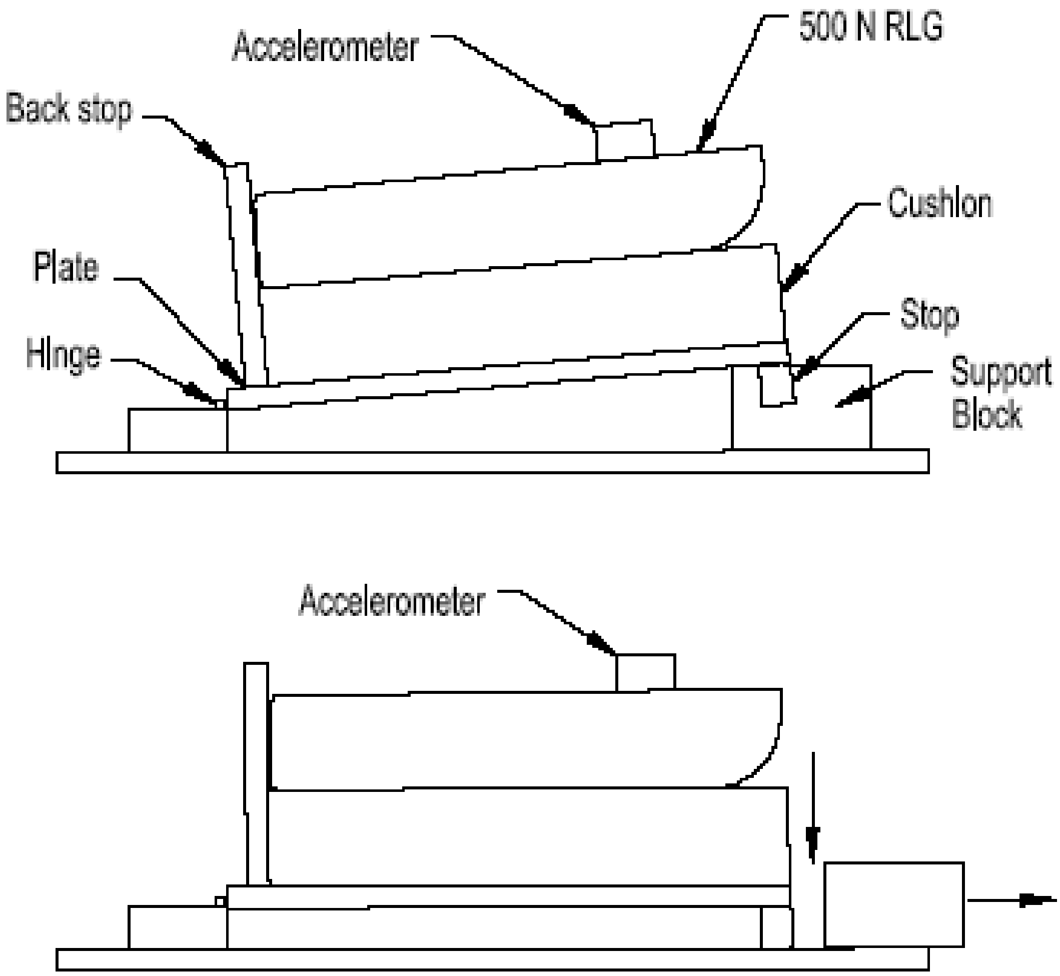

Figure 6: Impact Damping apparatus

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The accelerometer records the g-forces during free fall, and subsequent impact with the cushion. 3 parameters are reported:

Number of rebounds
A trace of acceleration against time is examined to determine how many times the indenter bounced on the surface of the cushion before coming to rest. A rebound must exceed 10% of the initial rebound to qualify.

Report output:

Number of Rebounds

Lower Number => More Energy Absorption

Maximum impact
The trace is examined to determine the maximum impact when the indentor hit the cushion

Report output:

Maximum Impact

Lower Impact => Smoother Ride

Rebound Percentage
The trace is examined to determine the ratio of the second rebound to the first rebound, expressed as a percentage.

Report output:

Rebound %

Lower % => More Energy Absorption

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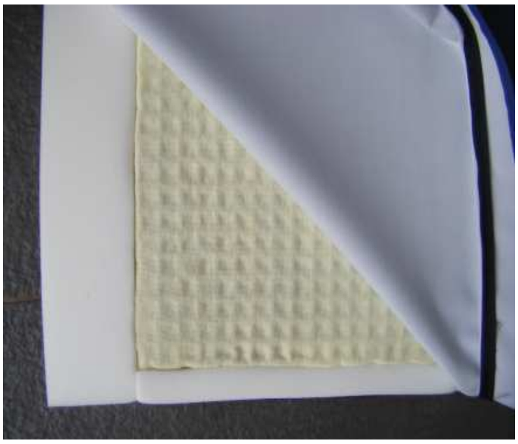
Meditec Gel Cushion 1



Description

A CMHR foam cushion, with an inlay of collapsible polymer gel grid encased in a stockinet .. Access by zip in outer cover.

Horizontal Stability

Horizontal Stiffness *(N)*	**355 +/-9**
Sliding Resistance *(N)*	**455+/-11**

Supplier

Meditec Ltd

Pressure Distribution

Peak Pressure (mmHg)	**85** +/-5
Contact Area (cm^2)	**1266**+/-8

Skin Microclimate

Temperature (1 hr) *°C*	**31**
Humidity (1 hr) *%RH*	**68**

Loaded Contour

Contour Depth (mm)	**36**
Overload Depth (mm)	**1**

Weight

Weight (kg)	**2.5**

Impact Damping

Number of Rebounds	**3**
Peak rebound *(g)*	**2.3** +/- 0.1
Rebound *%*	**18** +/-2

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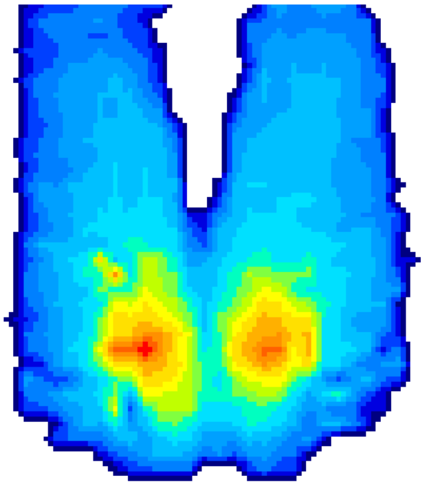
HR70 STANDARD FOAM REFERENCE 2



Description

Reference standard block of foam as specified by SADMERC protocols for wheelchair cushion evaluation. 100mm thick high resilience foam, 75 kgm-^{3} density.

Pressure Distribution

Peak Pressure (mmHg)	**220** +/-8
Contact Area (cm^2)	**1240**+/-14

Skin Microclimate

Temperature (1 hr) °*C*	**35**
Humidity (1 hr) *%RH*	**54**

Horizontal Stability

Horizontal Stiffness *(N)*	**139 +/- 12**
Sliding Resistance *(N)*	**189 +/-14**

Loaded Contour

Contour Depth (mm)	**40**
Overload Depth (mm)	**8**

Supplier

REFERENCE STANDARD

Weight

Weight (kg)	**1**

Impact Damping

Number of Rebounds	**4**
Peak rebound *(g)*	**1.7** +/- 0.3
Rebound %	**58** +/- 2

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