WALKING AND STOPPING OVER TACTILE PAVING

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SUMMARY

Theme Code : G. Pedestrian mobility & safety for liveable communities

Key Words: Tactile paving; Navigation; Detection

PURPOSE OF THE STUDY

Blister Tactile Surface Warning Indicators have been installed across the world to warn people of the proximity of the edge of pavements and other potential hazards. As such they are an essential safety aid to blind and partially sighted people. However, as is often the case, what benefits some people, creates a problem for others. For example, the IDGO consortium has reported from interviews that elderly pedestrians raised their dissatisfaction with having blister tactile paving ‘everywhere’ [IDGO 2010]. To achieve maximum benefit and minimum negative impact a number of features need to be understood better. There are a number of papers on the efficacy of tactile paving including some analysis on the width of surface required to allow safe detection and stopping distance [Pavlos et al. 1985; Peck & Bentzen 1987; Sueda 2000; Ståhl et al. 2010; Childs, Fujiyama, et al. 2010]. Yet in practice, there is wide variation in area covered by blister tactile surfaces in streets around the world, and even within individual local authorities.

MATERIALS AND METHODS

1. Literature Review

Both laboratory-based and real world experimental studies have been reported that include some discussion on stopping distances on tactile surfaces for blind or partially sighted participants. In all the laboratory work reported here, blind and partially sighted participants were asked to walk within a safe environment that included a number of discretely arranged different surfaces, stopping when they detected a change of surface [Pavlos et al. 1985; Peck & Bentzen 1987; Sueda 2000]. Laboratory tests allow many conditions to be controlled removing possible confounding variables. However, the level of difference in performance between a safe test environment and real world activity is
not known. Evidence of this can be seen in the difference between the laboratory tests and on-site tests of Peck & Bentzen [1987] where 100% of the participants detected the change within 30” (762mm) in the laboratory and within 21” (533mm) in a real world location. Note, location was not the only variable here, as the participants were not the same for each experiment. In later laboratory experiments including different materials, Bentzen et al. [1994] determined that 95% of the participants detected the change within 30” (762mm) and 48” (1.2m) were needed for 100% of the participants to detect the change. Although they did not measure stopping distance, Ståhl et al. [2010] noted from their tests in a street environment that there was no difference in detectability if the tactile surface was 1m or 1.5m deep.

Some experimenters have attempted to measure ‘precisely’ where participants have stopped; using tape measures from the start of the tactile surface to the toe of the front foot. However, as Sueda [2000] explain, it is difficult to judge exactly where a participant stops. This is due to a natural need to find a balanced position once the participant has detected a surface as this realisation may be early or late in the gait cycle, meaning additional foot adjustment may be necessary after detection. Consequently, a measurement in millimetres, or even inches, is of questionable accuracy or use. The measure used by Sueda [2000] was the number of steps taken over the tactile surface. In 91% of trials the participants had stopped by taking three steps or fewer. In 98% of trials the participants had stopped by taking four steps or fewer. It was difficult to determine the exact number of steps as the step length shortened and gait changed as the participants were stopping.

There is a difference between the questions
   1. ‘how much tactile paving is required to be detectable?’
   and
   2. ‘how far after the start of the tactile paving did the participant stop?’

The literature discussed here has dealt with the second question. To answer the first question, different depths of tactile paving must be tested. The following experiments start to consider this aspect.
2. Experiment Participants
This study was approved by UCL Ethics Committee (0410/005 – funded by Transport for London). Blind and partially sighted people were recruited; all of whom used the normal street environment unaccompanied (Table 1). The participants included guide dog owners, people who use a long cane and those who use no assistive device.

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-40</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>41-64</td>
<td>22</td>
<td>14</td>
<td>17</td>
<td>18</td>
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<tr>
<td>65+</td>
<td>3</td>
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<table>
<thead>
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<th>Gender</th>
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</thead>
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<tr>
<td>Male</td>
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<td>18</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>7</td>
<td>9</td>
<td>11</td>
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</table>

<table>
<thead>
<tr>
<th>Assistive Device</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cane</td>
<td>21</td>
<td>16</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Dog</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>None</td>
<td>7</td>
<td>3</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

The task for all participants was to travel from one designated place in the test area to another as if travelling through a normal street environment (explained in more detail in Childs, Thomas, et al. 2010). For some of these trials the participant would encounter one of the test surfaces, but on other trials they would not. This was to reduce any expectation on the part of the participants that they would always encounter a tactile surface. Each surface was approached up to six times for each participant.

3. Experiment layout
The experiments were all performed at the EPSRC funded Pedestrian Accessibility Movement Environment Laboratory [Childs et al. 2007]. This facility was arranged with an 80m² test surface laid out as a simulated street environment including different surfaces. The top surface of the test facility was predominantly concrete paving slab, but with test surfaces discretely located. The distance to the tactile surface was up to 4m when approached from 90°; when approached from 45° greater than 4m was available; with the approach distance being varied between trials. There were four test conditions (Table 2) all with the same 6mm Blister profile [Department for Transport 2003] laid covering 1.6m to ensure the participants encountered the surface with the minimum of redirection. The blister tactile was the same material (concrete) and colour (gray) as the surrounding pavers. Test 4 was designed as a repeat of Test 2 as a test-retest to determine the difference in running the same test but on different days. In Test 3 the tactile surface was on a 1:24 slope; with the approach (both from below and above) on a level surface. In these trials the participant approached the tactile from both directions.
Table 2 Blister Paving Test Characteristics

<table>
<thead>
<tr>
<th>Depth</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>400mm</td>
<td>800mm</td>
<td>800mm</td>
<td>800mm</td>
<td></td>
</tr>
</tbody>
</table>

4. Experiment Task

The participants were positioned so that they were facing either perpendicular to the surface or approximately 45° to it. They were asked before starting each trial to stop if they encountered a change in surface, otherwise to walk towards the experimenter at their normal walking pace using the experimenter’s voice to help with direction. The experimenter then went to the other side of the surface and asked the participant to walk towards them. The experimenter marked each trial according to whether the participant detected the surface or not, noting where the participant had stopped (before stepping on the tactile surface; with their front foot on the first Blister paver; with their front foot on the second Blister paver; after stepping off the tactile surface; or failed to stop until asked to do so). In some cases the participant took a step back to get their balance, but the experimenter noted the furthest point forward that the participant reached. Each paver was 400 x 400 mm.

RESULTS

In 19% of trials over the 400mm tactile in test 1 the participant failed to detect the surface and stop. It would be expected that there would be no difference in the stopping position between Tests 2 and 4 as they were run over the same tactile surface and with similar numbers of people with guide dogs, long cane or no guide. There is however a difference between the Tests although the small test numbers do not show statistical significance: in Test 2 the tactile surface was detected more often before it was stepped on whereas in Test 4 the tactile surface was detected more often with the first step onto it. Given the additional change of slope for Test 3 it might be expected that the tactile surface would be detected more often before or on the first tactile paver. The results indicate this, although the small test numbers do not show statistical significance.

Most of the partially-sighted people who navigated without an assistive device stopped on the second paver (approximately 60%), with the majority of the remainder stopping on the first paver.

Almost 30% of the trials with people with Guide Dogs in Test 2 stopped before the participant reached the tactile surface. This may indicate very well trained dogs, or that these participants had some other cue that was not present in the other Test days. Around 60% of the trials in Tests 2, 3, and 4 stopped with the participant on the second tactile paver.
Of particular interest are those who stopped after the tactile surface. From further analysis of the video, one participant took two steps beyond the tactile surface onto the edge of the second paver; approximately 500mm after the tactile surface. All the others in this category had part of their front foot either on the tactile surface, or very nearly touching it.

DISCUSSION

In spite of the variety of experimental approaches, the results from the literature and our laboratory tests are consistent. As may be expected, people who use a long cane detect changes in surface earliest, in many cases before stepping on them. From the number of people who failed to detect the surface, 400mm blister tactile surface is insufficient whereas 800mm resulted in comparable levels of detection as reported in the literature for greater lengths of tactile surface. The literature indicates a minimum depth of 800mm, but our tests indicate that people may be able to reliably detect the blister tactile paving at widths less than this. Consequently there is value in testing widths between 400mm and 800mm. It is important to note however, that the start of the tactile paving cannot be placed closer to the hazard otherwise people with not have sufficient space for stopping steps; where people take additional steps forward before coming to a complete stop. This would raise the importance of how tactile surfaces are integrated into street design.

CONCLUSION

The UK Inclusive Mobility guidance recommends that the back edge of blister tactile surface be a minimum of 800mm from the kerb edge [Department for Transport 2003]. Whilst a width of 800mm may be sufficient for detection, the results indicate that many blind or partially sighted people may detect and stop right on the edge of the footway/vehicle lane. However, increasing the width of blister tactile surface creates an obstacle for others. A compromise may be starting the tactile paving farther from the edge. Further tests could indicate if widths less than 800mm are still sufficiently detectable.

REFERENCES


Conference on Mobility and Transport for Elderly and Disabled Persons. Hong Kong, China. Available at: http://eprints.ucl.ac.uk/97526/.


