TRANSPORT RESEARCH LABORATORY

Delineation for cyclists and visually impaired pedestrians on segregated, shared routes

Prepared for Mobility Unit, Department of the Environment, Transport and the Regions

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Executive Summary

A segregated, shared route is one of a range of options available for separating cyclists from other road traffic. With this type of facility one side of the route is designated as cycle track, the other as footway. However, although pedestrians retain the right to use the cyclist side of the facility, cyclists can only use their designated part of the route. The two can be separated by a difference in level, by a barrier or a raised white line. Research in the 1980's (Williams, 1987) identified two tactile surfaces for helping visually impaired people to use segregated, shared routes. One of the surfaces consisted of a bar pattern paviour which is used to inform people that they are entering or leaving the facility, and which tells them that they are walking along the correct side of the route. The second tactile indicator consisted of a profiled white line, generally formed from thermoplastic (Diagram 1049.1 in the Traffic Signs Regulations and General Directions). This 'central delineator' is installed along the length of the route and helps visually impaired people to remain on the pedestrian side of the route.

Recently, visually impaired people have reported that they are again experiencing problems with keeping to their side of the segregated, shared route. There appear to be two key reasons for this. Firstly, local authorities have reported that the thermoplastic form has a tendency to slump in height and lose its profile. Secondly, new types of long cane are now available, and people using the roller ball type of canes, which maintain contact with the ground rather than tap from side to side, have reported problems detecting the central delineator.

The research reported here aimed to determine whether the existing profile is effective when used by people with roller ball canes, whether it is more effective in a different material, and whether a different profile should be recommended.

Ten delineating strips were tested by visually impaired people, cyclists and other pedestrians. Five of the delineating strips conformed to Diagram 1049.1, with two being at a height of 12 mm and three at 20 mm. Block paviors and a rubber 'imprint' material were used to form the profiles as well as thermoplastic. The remaining five delineating strips had a range of experimental profiles.

Forty eight visually impaired people were asked to walk alongside each of the ten profiles, using their long canes to keep in contact with the delineating strips. It was found that people using the roller ball canes experienced problems with maintaining contact with the 12 mm high thermoplastic strip, but that the 20 mm high version of Diagram 1049.1 was effective, particularly when formed from block paviors and the 'imprint' material. When asked to give their preference, most people preferred these latter two delineating strips.

Forty two cyclists rode over the delineating strips and gave their comments regarding the safety of each strip. Around a third of cyclists thought that the 20 mm profiles of Diagram 1049.1 were not safe to cross, generally because it made them feel uncomfortable. Those experimental delineating strips with a vertical upstand were not favoured.

The report concludes that the profile of Diagram 1049.1 is the best compromise between the needs of visually impaired people and cyclists, as found in the original research conducted by Williams (1987). As the profile has no vertical upstand, it can be traversed by cyclists in an emergency, yet it can be readily detected by people using both the traditional type of long cane and those fitted with a roller ball.

1 Introduction

In 1995, 3,966 people in the UK were killed or seriously injured when riding a bicycle. A further 20,947 sustained minor injuries (Road Accidents Great Britain, 1996). Cycle accidents are, however, known often to go unreported to the police, and these figures are therefore likely to be underestimates (Mills, 1989; James, 1991).

A segregated, shared route is one of a range of options available for separating cyclists from road traffic (Department of Transport, 1986; Davies, 1996). With this kind of facility, the route is divided in two with cyclists cycling on one side of the facility and pedestrians walking along the other side. The two sides can be separated by a barrier, change of level or by a raised white line. A painted logo of a bicycle is used, together with signing, to inform people as to which side they should use.

In the 1980's it was reported that visually impaired people were experiencing difficulties using segregated, shared routes. As they could not see the white line, they found it difficult to stay on their side of the facility, and often did not realise they were walking along a facility that was shared with cyclists. In response, the Department of the Environment, Transport and the Regions (DETR) commissioned research to identify tactile signs to let people know that they were entering the facility, to identify the pedestrian side, and to help them keep to this side (Williams, 1987). This research concluded that two forms of tactile indicators could be used for these purposes. A bar pattern tactile paviour (see Figure 1) is now recommended for installation at the start and end of the facility and at intervals along the route, with the bars crossing the direction of pedestrian travel on the pedestrian side, and turned through ninety degrees on the cyclist side. Instead of a painted white line, a profiled line (Figure 2) was found to be an effective means of helping visually impaired people keep to the pedestrian side of the shared footway (Diagram 1049.1 in the Traffic Signs Regulations and General Directions). This profiled line, called a 'centraldelineator', was originally tested with visually impaired people and cyclists in both thermoplastic and rubber materials (Williams, 1987).

Since this research was conducted, some visually impaired people have reported difficulties keeping to one side of the central delineator. There appear to be two main reasons for this difficulty: deficiencies in the delineator profile and developments in the design of long canes. Some local authorities have claimed that it is difficult to lay the central delineating strip with the recommended profile in thermoplastic, and that the material is prone to losing its profile and height ('slumping'). There are also now a wider variety of long canes available to visually impaired people.

Long canes are the most common mobility aid used by visually impaired people. They are used to scan the ground in front of the person. The cane is swept in an arc from side to side, extending just beyond the width of the body. With the traditional type of cane, the cane is tapped against the ground on each side. However, roller ball canes are increasing in popularity. With these, the cane maintains contact with the ground as it is swept from side to side. Some people have commented that the thermoplastic strip is harder to detect with the roller ball cane than with the traditional types of long canes because of the way it responds to the normal roughness of the footway.

The aim of this research was to test a variety of central delineators to determine whether:

a the existing profile line 1049.1 is effective when formed from a thermoplastic material

b the existing profile line 1049.1 is effective when formed from other materials

c whether a different profile is required.

2 Details of the test central delineating strips

In all, ten delineating strips were tested on a disused airfield in West Malling, Kent. Each strip was laid as a 10m straight section, followed by a shallow bend to the right and then a shallow bend to the left to give a total strip length of 20 metres (see Figure 3). All the strips were installed to a width of 150 mm. To ensure that the participants evaluated the tactile qualities of the profiles, as opposed to any differences in contract between the strip and the surrounding footway, the delineating strips were all painted white.

Five of the delineating strips were installed in accordance with Diagram 1049.1, with heights of both 12 and 20 mm (see Figure 2). Their details are given below. It should be noted that, to ensure the clarity of this report, the strip numbers given below do not correspond to the numbers given to the strips on the airfield.

Strip 1 12 mm thermoplastic
This strip was laid to the minimum recommended height of 12mm and was formed from thermoplastic which was used in accordance with BS 3262 parts 1, 2 and 3, class A. The material was formed using rib line plastic 70/20 BS 5659 and the strip was laid by hand. This strip is currently used on existing segregated, shared facilities.

Strip 2 12 mm blocks
This strip had the same profile and height as Strip 1, but consisted of concrete blocks, 200 mm long, provided by *Marshalls Mono.* The blocks were manufactured in accordance with BS 6717. The blocks were set in a shallow trench.

Strip 3 20 mm thermoplastic
This strip was laid to the maximum height of 20 mm. It was formed from a thermoplastic material to BS 3262 parts 1, 2 and 3, class A and was formed using vibraline. The strip was laid with a machine with gave a visibly better finish than strip 1, which was hand laid.

Strip 4 20 mm brick
This surface was in accordance with Diagram 1049.1 and was in current use. It has the same profile as Strip 3, but

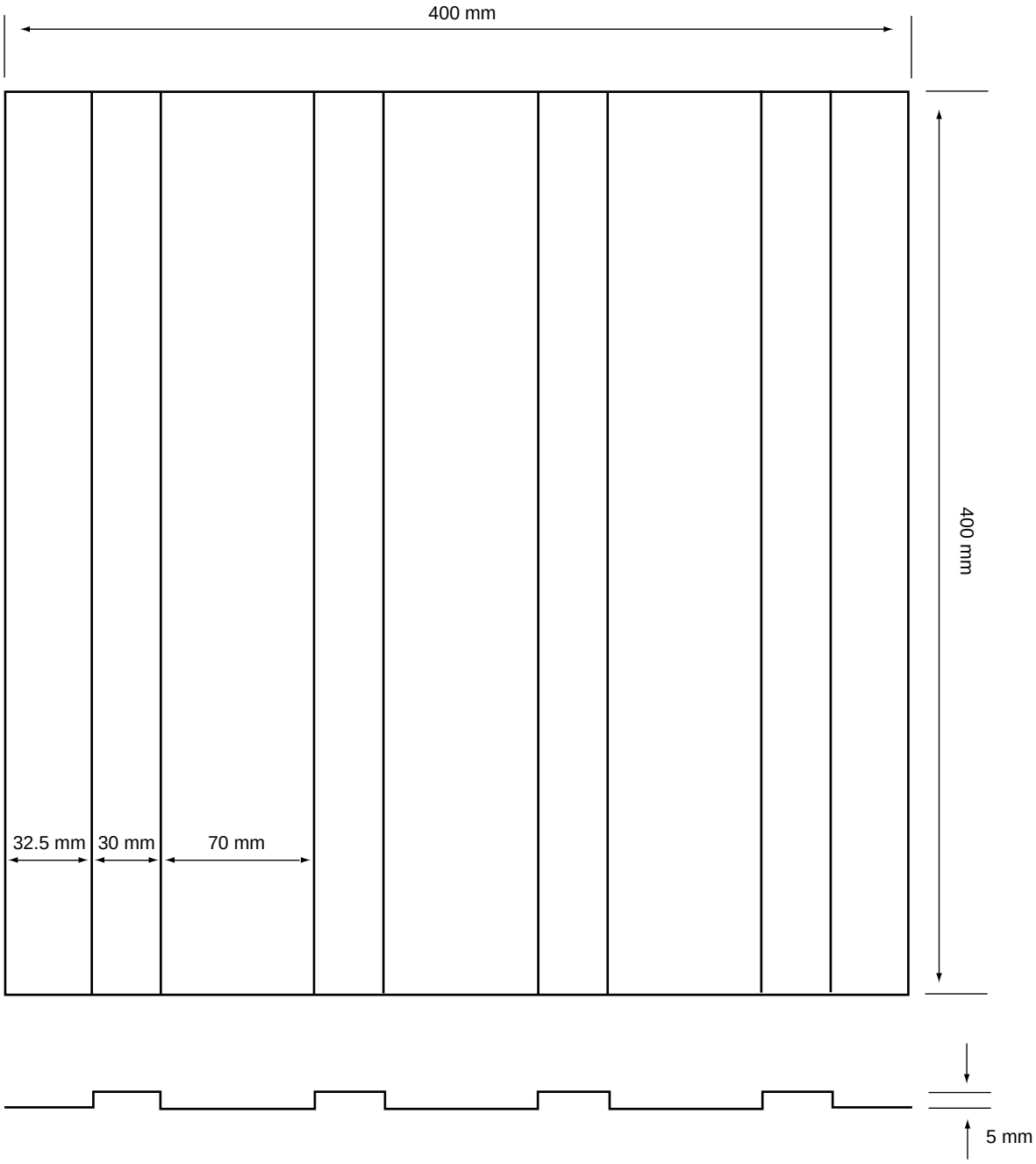


Figure 1 Tactile entry treatment

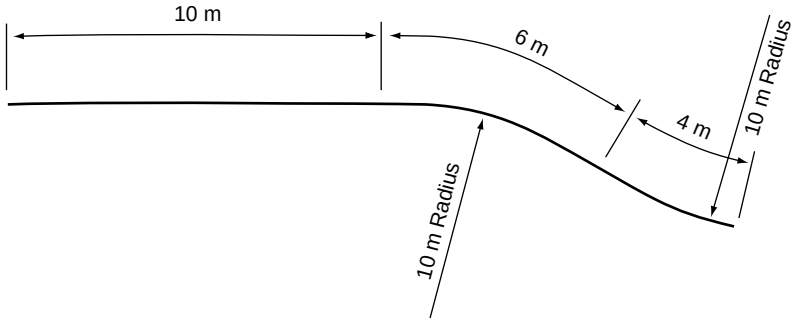
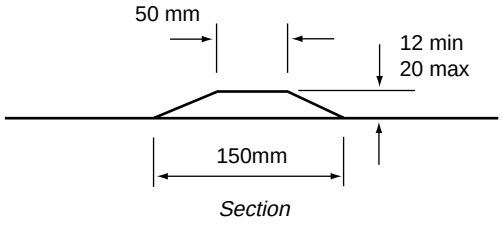


Figure 3 Layout of the test delineating strips



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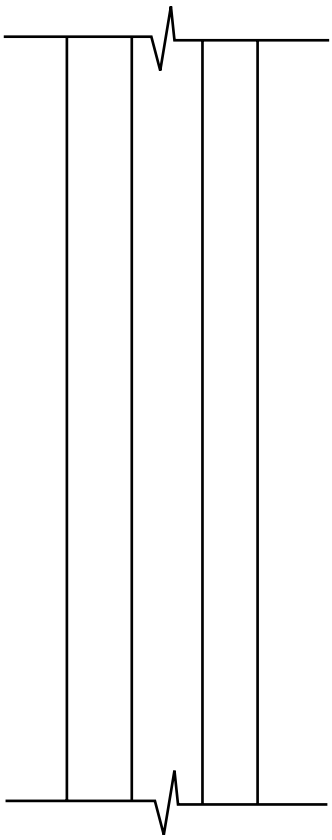


Plan View

Figure 2 Profile line 1049.1

was made from clay blocks, supplied by *Blockleys Brick Ltd*. The blocks were manufactured in accordance with BS 6677. The blocks were set in a shallow trench.

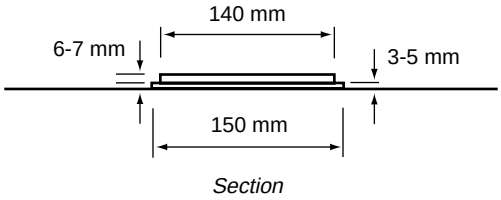
Strip 5 20 mm Imprint
This surface was installed in accordance with Diagram 1049.1, but the material tested had not been used for this application before. It had a similar profile to Strips 3 and 4, but was made from a material which consisted of a hot applied polymer modified bitumen based compound incorporating graded rubber and granite aggregates, reinforced with metal and glass fibres. The material was formed by hand using a mould.

The remaining five delineating strips were experimental profiles. Their details are given below:

Strip 6 Raised Rib Line
The idea for this strip was taken from the prescribed road markings 1012.2 and 1012.3, commonly known as raised rib markings. These were developed to improve visual delineation of the carriageway edge in wet conditions at night, and provide an audible/vibratory warning to drivers should they stray from the carriageway. *Hi Way Services* provided the ribbed strip for testing. The material consisted of preformed rectangular ribs laid on a screed thermoplastic, in accordance with BS 3262 and BS 6088. The dimensions of the ribs were as follows:

Width:	45 mm
Height:	6 mm
Length:	150 mm

The bars were laid 200 mm from centre to centre (see Figure 4).



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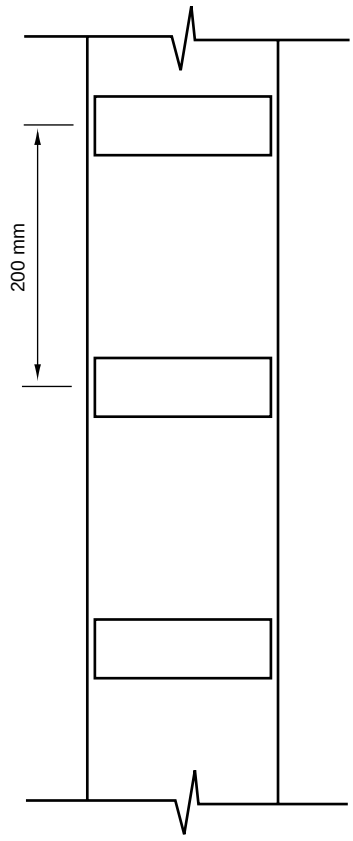

Plan View

Figure 4 Raised rib line

Strip 7 Plastiroc
This material, plastirocagate, was a two component methacrylic road cold plastic. It was laid to a width of 150 mm using a hand screed at a thickness of 5 - 6 mm (see Figure 5). The surface was then given a crosshatch pattern, formed by rolling the material with a special roller.

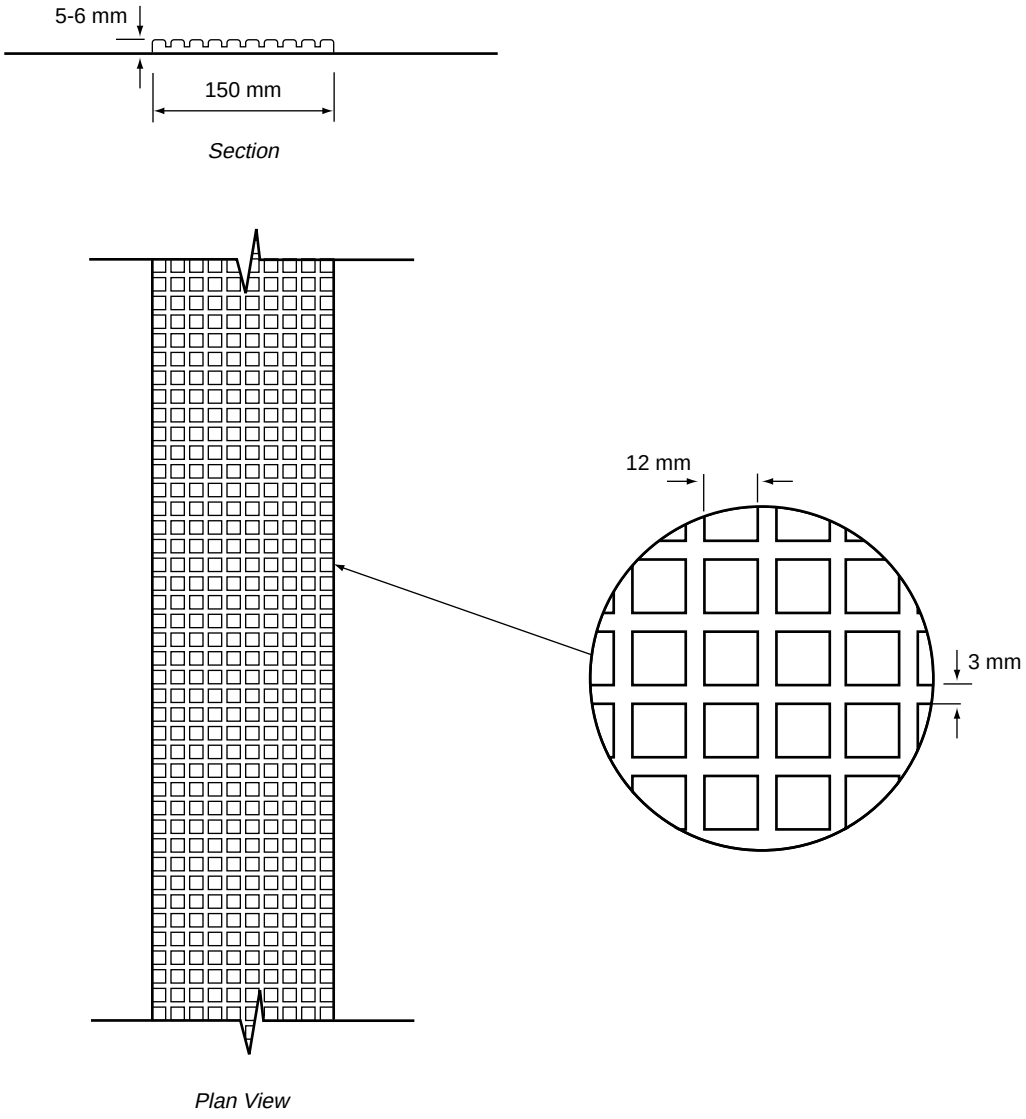

Figure 5 Plastiroc profile

Strip 8 Horizontal Bars
This strip was put forward as a way of helping people to know which side of the delineating strips they were walking along. It consisted of preformed strips laid on top of a thermoplastic screed, 3-5 mm thick and 150 mm wide. A continuous bar was laid along one side of the 150 mm wide base line with small bars at 90 degrees to this at 500 mm centres (Figure 6). The supplier was *Hi Way Services*.

Strip 9 Inverted T Shape
This profile was made from the same material as strip 5, but the profile was of an inverted 'T' which was 5 - 6 mm thick with an upstand of 50 mm wide in the centre of 12 mm (Figure 7).

Strip 10 Flexitec Delineators
The preformed profiles making up this strip were 1200 mm long by 45 mm high with a chamfered dome shape (Figure 8). The product consists of rubber, recycled from vehicle tyres. A binder is added to the rubber and the mixture moulded under pressure, incorporating a metal strengthening bar to obtain the finished profile. The bars were bolted to the airfield asphalt surface.

This final strip was considered too substantial to be tested safely by the cyclists, but the views of the visually impaired participants were sought.

3 Evaluation by visually impaired participants

3.1 Method

Voluntary organisations and a college for visually impaired people were contacted and asked to provide adult participants for the study. To ensure that the tactile quality of the test strips was fully evaluated, the volunteers were either totally blind or had little useful residual vision. As people using the roller ball type of cane had particular difficulties with detecting the current thermoplastic strip, the organisations were also asked to ensure that some of the volunteers used this type of long cane.

Guide dog owners receive long cane training as part of their mobility training to use guide dogs. This ensures that

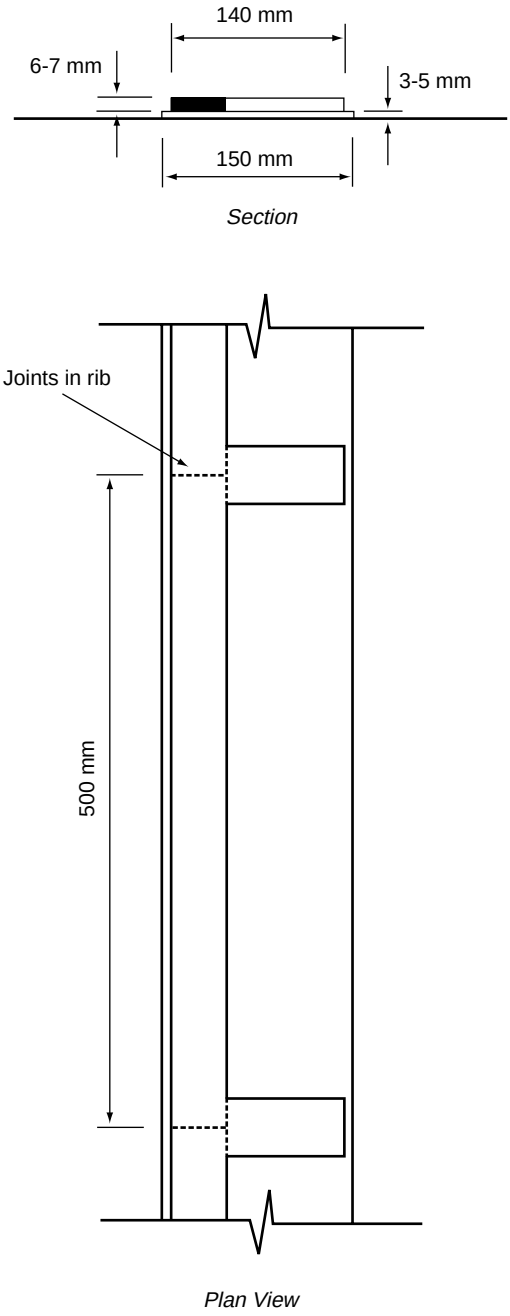

Figure 6 Horizontal bars

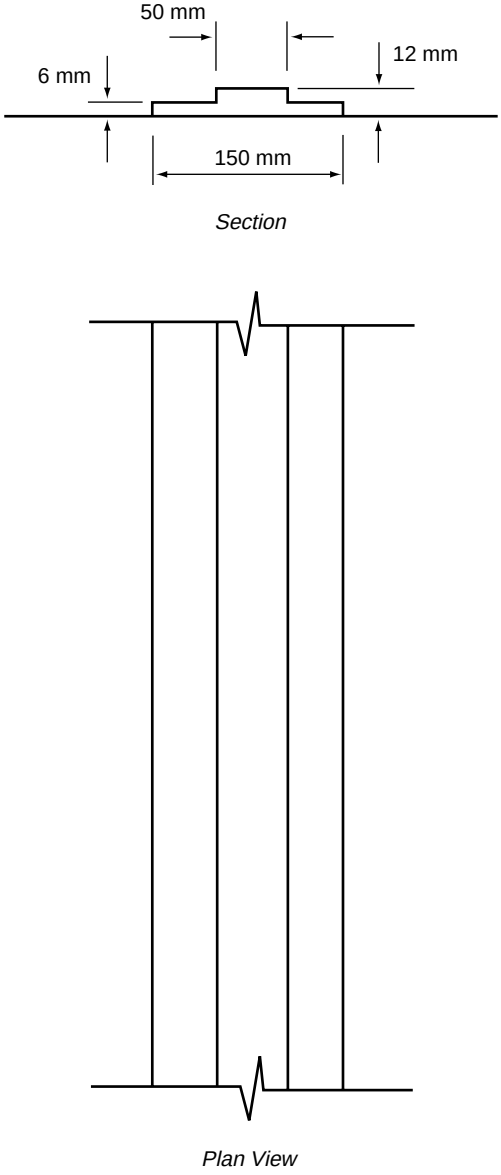

Figure 7 Inverted ‘T’

they are able to maintain independent mobility when their dogs are unwell or unavailable. Volunteers who normally worked guide dogs were asked to use their normal long cane in the trials. This was because difficulties with guide dogs had not been reported and in any case, guide dogs would be unlikely to be able to keep to one side of a raised strip without training.

The participants were first asked a series of questions relating to their level of vision and mobility aid. They were also asked whether they had ever used a segregated, shared route and, if they had, whether they had encountered any difficulties. They were then asked to evaluate each of the delineating strips in a random order.

At each strip, the participants were positioned a metre back from the start of the strip, and asked to walk forward and see if they could detect the strip. If the participant failed to locate the strip, the experimenter showed them where the strip was. If the participant was still unable to detect the strip with their cane, they were escorted to the next strip.

In order to assess whether, once having detected the strip, the person could walk keeping to one side of the delineating strips, the participants were asked to walk to one side of the strip until they reached the end (20 metres). If the participant lost contact with the strip, the experimenter helped them to relocate the strip. If the person lost contact with the strip more than three times, the exercise was abandoned. This procedure was repeated with the strip on the person’s left hand side.

A person may be able to keep to one side of the delineating strip, but only with difficulty. The participants were therefore asked to rate how easy they had found it to keep to the correct side of the line. They were also asked to state which strip they preferred overall.

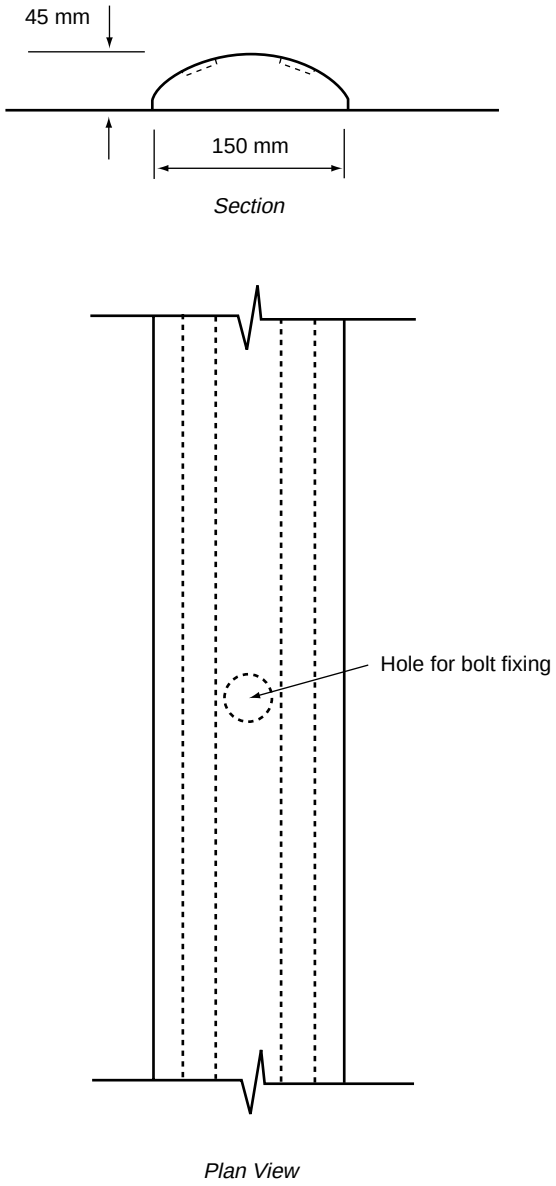

Figure 8 Flexitec delineators

3.2 Results

3.2.1 Personal characteristics

Forty eight[1] visually impaired people took part in the trials. Their ages ranged from 16 to 73 years. Twenty seven of the participants could see nothing at all or could only perceive light from dark. These people have been classified in this report as having 'no useful vision'. Sixteen people said they normally used a guide dog. When taking part in the trial, most people (85%) used a long cane and the remainder used a symbol or guide cane[2].

Twenty one of those using a long cane had the new type of roller ball tip which maintains contact with the ground in a sweeping motion across the body. The remaining twenty long cane users had the traditional cane tip which is used for tapping from side to side. No statistically significant relationship was found between participants' level of vision and whether they used canes with roller ball tips or traditional tips.

3.2.2 Detection of the delineating strips

The participants were asked if they could detect the presence of the delineating strips with their cane. Figure 9 shows that all the participants detected strips 4, 5 and 10 when it was on their right hand side (the results from the left hand side are similar and so are not presented here). Generally, a higher percentage of participants who had some useful residual vision detected each strip, compared with participants who had no useful vision. For example, 81 per cent of participants with residual vision detected strip 7, compared with 37 per cent of totally blind participants.

3.2.3 Keeping to one side of the delineating strips

3.2.3.1 Level of vision

People with no useful vision

If the participants were able to detect the strip, they were then asked to follow it to its end keeping to one side, i.e. maintaining contact with the strip using their cane. All twenty seven participants with no useful vision were able to follow delineating strips 5 and 10. Ninety per cent or over followed strips 2, 3, 4, 8 and 9 to their end. However, Figure 10 shows that substantial proportions of these participants lost contact at least once with delineating strips 2, 3 and 9 (37 per cent, 40 per cent and 30 per cent, respectively). People with no useful vision were unable to follow strip 7.

People with some useful vision

Figure 11 shows that all 21 participants with some useful residual vision were able to follow and therefore keep to one side of delineating strips 2, 4 and 5, and ninety per cent or more followed strips 3, 8, 9 and 10. Substantially fewer participants with residual vision lost contact with the delineating strips, compared with participants who were either totally blind or had no useful sight.

3.2.3.2 Effect of cane tip type

Roller ball canes

All 21 participants who used roller ball canes followed strips 5 and 10 to the end, although two participants lost contact at least once with strip 5 and one person lost contact with strip 10. Most of the participants were able to follow strips 2, 3, 4, 8 and 9. However, a higher proportion of people lost contact at least once with delineating strips 2, 3 and 9 (see Figure 12).

Traditional tip canes

All 27 participants who used canes or sticks with traditional tips followed strips 2, 4, 5, 6 and 8 to the end. However, a high proportion of participants lost contact with strip 2 at least once. Most of the participants could follow strip 10 to the end without losing contact with the strip, whereas a similar number were able to follow strip 3 but a higher proportion of people lost contact with the strip (Figure 13). Strip 7 could not be followed by many of the participants.

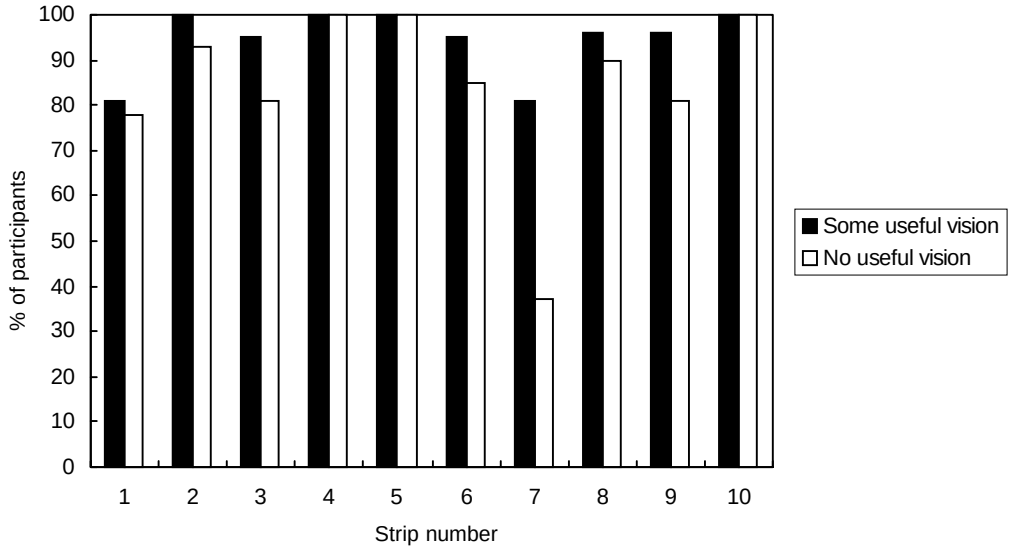

Figure 9 Detection of strips (right hand approach) by level of vision

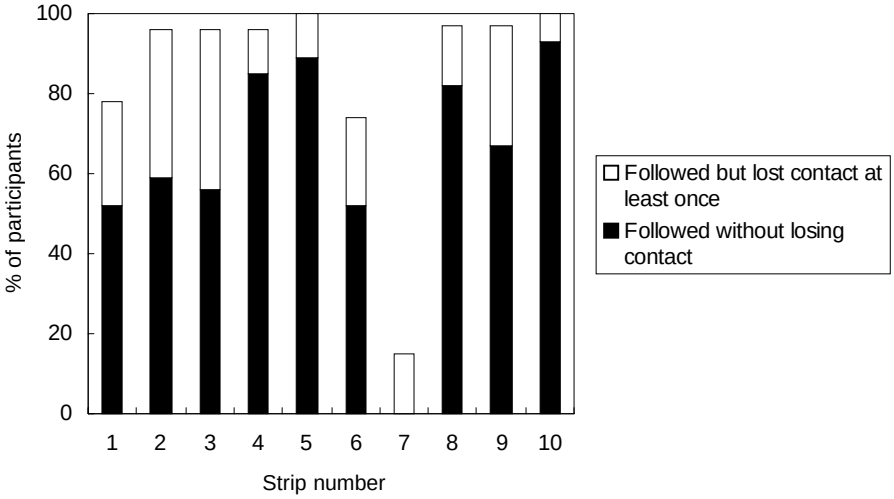

Figure 10 Percentage of participants with no useful vision who followed each strip

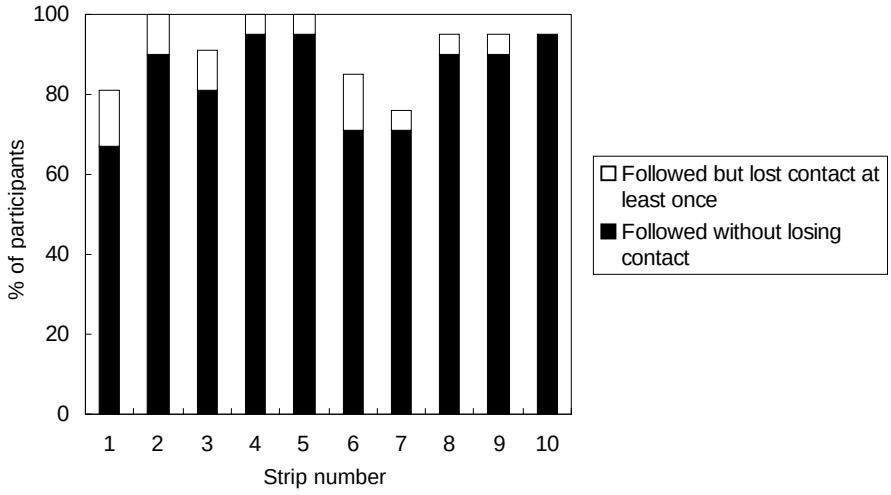

Figure 11 Percentage of participants with residual vision who followed each strip

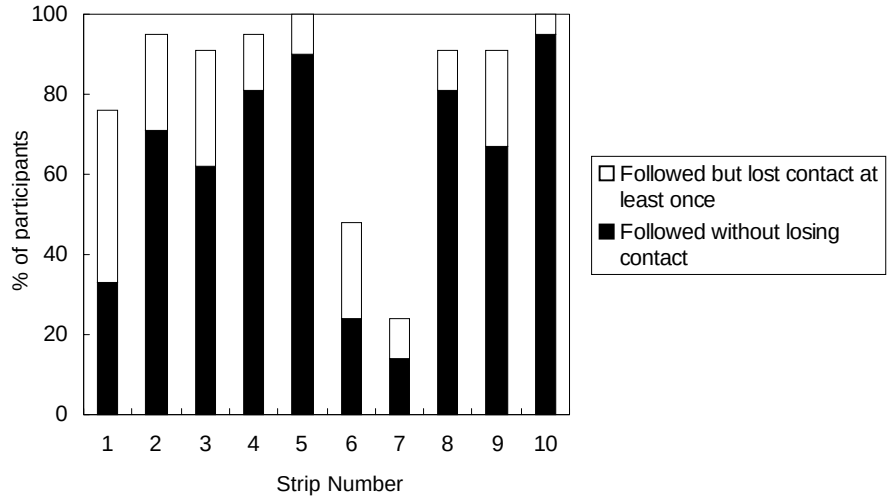

Figure 12 Percentage of participants using roller ball canes who followed strips

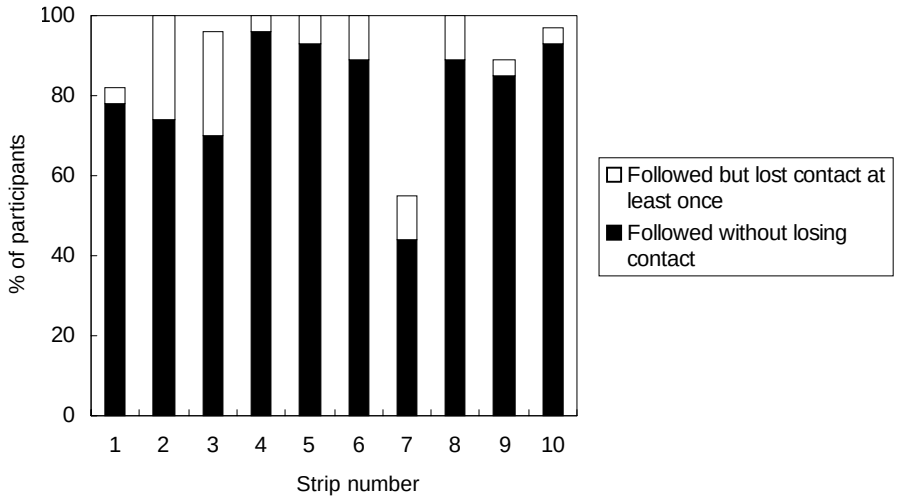

Figure 13 Percentage of participants using traditional tips who followed strips

3.2.4 Ease of keeping to one side of the delineating strip

The participants were asked to rate how easy they had found it to keep to one side of the strip. Figure 14 shows that strips 4, 5 and 10 were rated as easy to follow. These are the surfaces that most of the participants were able to follow to the end of the strip. Overall, strips 1, 6 and 7 were not favoured by the participants, which corresponds with the low numbers who were able to follow them.

3.2.5 Preference for delineating strip

After testing all the delineating strips, the participants were asked which strip they preferred. Strip 10 was not tested by the cyclists because it was felt to be unsafe, and so the participants were asked to state their preference before they had tested this surface.

When asked for their preference of strips 1 to 9, most of the participants (55%) said that they would prefer strip 5 to be used on segregated, shared routes (Figure 15). The second highest percentage (48 per cent) preferred strip 4. Both of these delineating strips were the 20 mm version of profile line 1049.1.

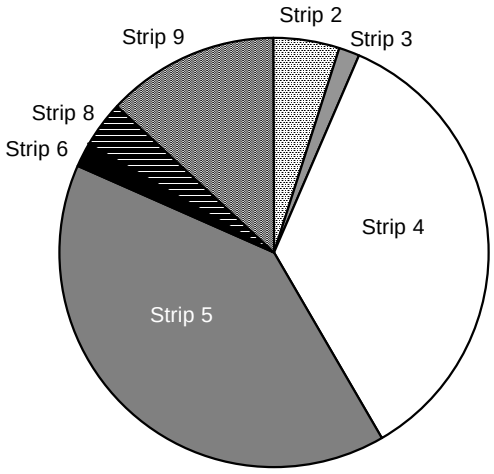

Figure 15 Preferred strip (1 to 9)

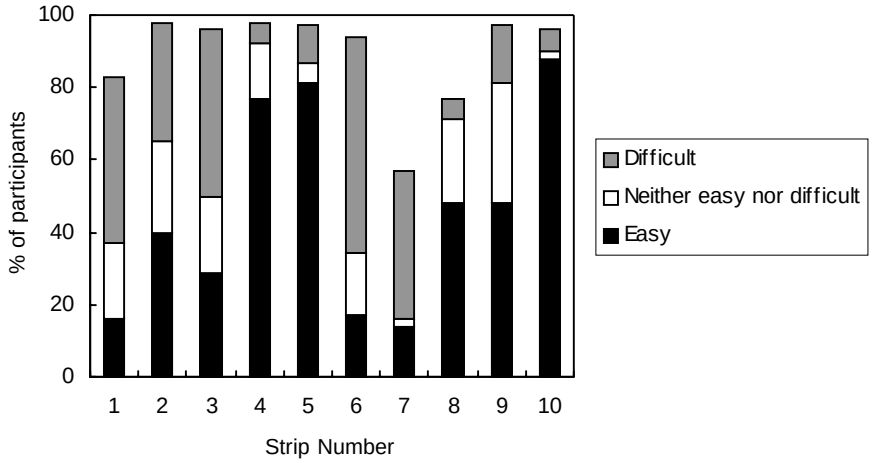

Figure 14 Ease of following the strip

3.2.6 Comments about the delineating strips

Although the participants could follow most of the delineating strips, some experienced difficulties with following them. In particular, bars which were horizontal to the participant caused problems because the traditional type of cane became snagged (e.g. strips 6 and 8). Strip 5 caused the cane to snag because it had a rough surface (see Section 8). The three main comments on each strip are given below in Table 1.

It should be noted that the participants were not asked to give any comments on the strip if they were unable to detect it. The percentages given are therefore out of the number who were able to detect the strip.

Table 1 Comments about each delineating strip

Strip	*Details*	*Top three comments*	*% of those who detected the strip*
Profile Line 1049.1			
1	12 mm Thermoplastic	Not pronounced enough	53
		Difficult to follow	24
		It is no good	8
2	12 mm blocks	Not pronounced enough	17
		Difficult to follow	17
		It sounds different	11
3	20 mm Thermoplastic	Not pronounced enough	24
		Difficult to follow	31
		Cane rolls over the top	10
4	20 mm bricks	Easy to follow	33
		Easy to detect	10
		Cane rolls over it	6
5	20 mm ‘imprint’	Easy to follow	40
		Very detectable	8
		Cane snags	6
Experimental profiles			
6	Horizontal bars	The cane snags	53
		It is no good	16
		Cane does not detect surface because it goes through the gaps	16
7	Plastiroc	It is no good	41
		Not pronounced enough	19
		Difficult to follow	11
8	Raised rib line	Not pronounced enough	24
		Easy to follow	20
		Cane snags	16
9	Inverted T shape	Easy to follow	26
		Difficult to follow	21
		Not pronounced enough	14
10	Flexitec delineators	Easy to follow	35
		Cane snags	31
		Could be a tripping hazard	29

4 Evaluation by cyclists

4.1 Method

The Cyclist Touring Club was contacted and asked to provide volunteers for the trials. This included members of the Club and their friends. Staff of the Tonbridge and Malling Borough Council were also approached and asked to take part.

The cyclists were asked to complete a short questionnaire which asked about their personal details, the type of bicycle they owned and how often they cycled. They were also asked their views on segregated, shared routes. The cyclists were then asked to make sure their tyres were inflated to the correct pressure (a pressure gauge and pump were provided) before taking part in the trials.

The cyclists approached strips 1 to 9 in a random order. They crossed the delineating strips in two directions. First they were asked to cycle alongside the straight section of the strip (‘side approach’). When they reached the bend in the strip, they were requested to cycle across the strip. They were then asked to approach the strip at a right angle and cross it. All the cyclists were told that they could refuse to cross a strip, but no-one did. After both manoeuvres, the cyclists were asked to rate how safe they had felt when crossing the strip. If they had felt unsafe, they were asked to give the reasons for this rating.

4.2 Results

4.2.1 Personal characteristics

A total of 42 cyclists took part in the experimental trials. Their ages ranged from 7 to 77 years. Twelve of the cyclists were aged 16 years or less, and nine were aged 60 or over. Twenty eight of the cyclists were male.

The cyclists were asked to describe the type of bicycle they normally rode. Over a third of the participants normally used touring bicycles. Nearly a third (32 per cent) used mountain bikes, either exclusively or in combination with other types of bicycle. One female participant did not normally cycle and did not have a bicycle of her own.

4.2.2 Side approach

When approaching the strip from the 'side approach', most participants said that strips 1, 2, 3 and 7 were safe (89 per cent, 81 per cent, 83 per cent and 93 per cent, respectively). Figure 16 shows the percentage of cyclists rating the strips as either unsafe or neither safe nor unsafe. Over a third of participants said that strips 4 and 5 (the 20 mm profile line 1049.1) were unsafe or very unsafe.

No statistically significant associations were found between whether participants considered the delineating strips to be unsafe or safe, and age, gender, frequency of cycling, type of bicycle, tyre width, diameter of tyres, and tyre pressure.

The reasons for rating the delineating strips as 'unsafe' are given in Table 2.

4.2.3 Right handed approach

Figure 17 shows the percentage of cyclists rating the strips as either safe or neither safe nor unsafe. Large proportions of participants said that strips 4 and 5 were unsafe to cross (33 per cent and 38 per cent, respectively).

The participants reasons for rating the delineating strips as unsafe are given in Table 3.

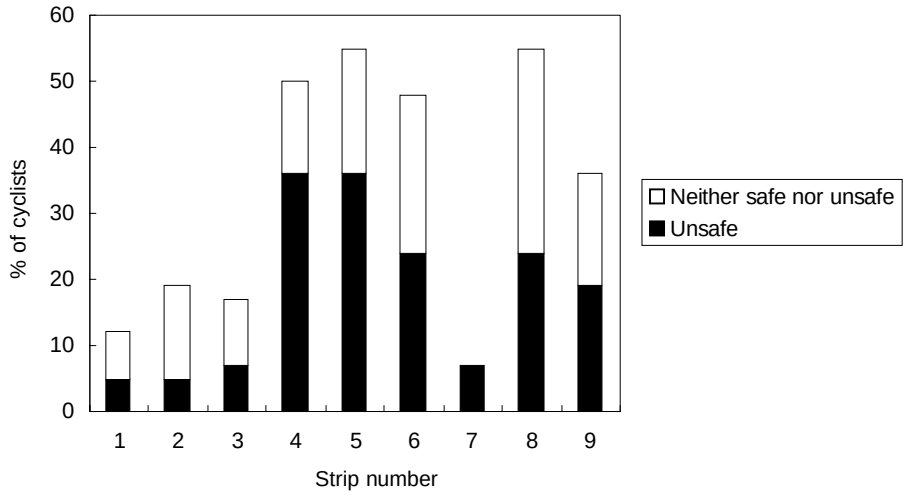

Figure 16 Rating of safety from side approach

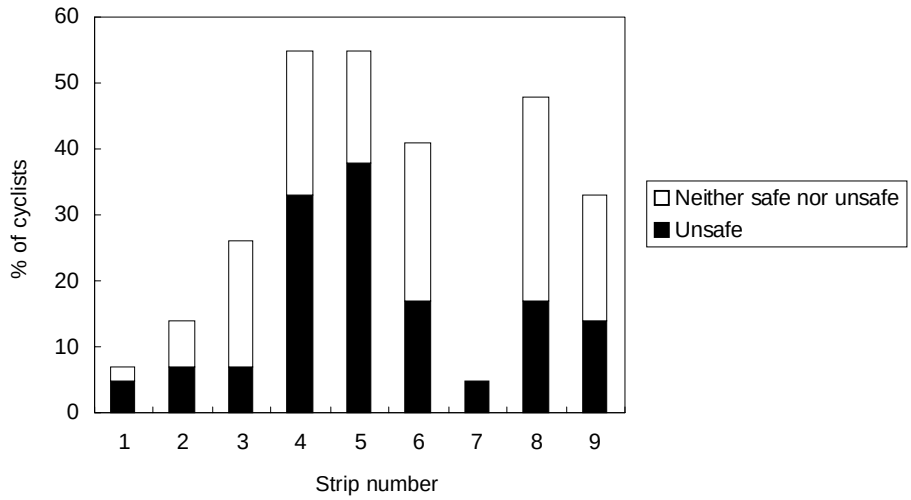

Figure 17 Rating of safety from right angled approach

Table 2 Reasons for rating the delineating strips as 'unsafe' (side approach)

Strip	*Reasons*	*No. of comments*
1	Cycle could slide on the strip	1
	Felt no different to footway and was no good as a guide	1
2	Could not feel it	1
	Could be slippery if wet	1
3	Too high	3
4	Too high	8
	Bumpy	3
	Could be slippery if wet	1
	Interfered with steering	1
	Could feel child trailer tipping	1
5	Too high	9
	Bumpy	3
	Could be slippery if wet	1
	Too like a kerb/not gradual enough	1
	Don't know	1
6	Felt bumpy	4
	Ridge affected steering	2
	Too high	2
	Disliked pattern	1
	Made cyclist feel unsafe	1
7	Could not feel it	2
	Could be slippery if wet	1
8	Too high	2
	Uncomfortable	1
	Wheels could get caught	1
	Wheels could slide in the gaps	1
	Disliked	1
9	Narrow strip interfered with wheels	5
	Skidded	1
	Disliked	1
	Don't know	1

Table 3 Reasons for rating the delineating strips as unsafe (right angle approach)

Strip .	*Reason*	*No. of comments*
1	Could interfere with steering	1
	Don't Know	1
2	Could be slippery if wet	1
	Too high	1
	Lifted front wheel of bike/lost traction	1
3	Too high	2
	Don't Know	1
4	Bumpy	6
	Too high	4
	Could stop the bike if travelling slowly	1
	Empty trailer was tipping	1
	Don't Know	2
5	Too high	9
	Uncomfortable	3
	Could stop the bike if travelling too slowly	1
	Don't Know	3
6	Bumpy	3
	Gaps not wide enough	1
	Ridge edge could cause loss of balance	1
	Disliked	2
7	Could not feel it	1
	Don't know	1
8	Too high	1
	Bumpy	1
	Disliked	1
	Don't know	4
9	Bumpy	1
	Don't Know	5

5 Evaluation of delineating strips by other pedestrians

5.1 Method

An attempt was made to test the safety of the delineating strips with regard to their perceived safety for pedestrians, including those with mobility impairments. A small sample of people were asked to walk over the strips and then rate how safe they thought the strips were for pedestrians. This included staff of the Tonbridge and Malling Borough Offices, and some local mobility impaired people. One person tested the surfaces with a children's buggy. If any of the surfaces were rated unsafe, the person was asked to give their reasons.

5.2 Results

5.2.1 Personal characteristics

Sixteen participants took part in the trials. The ages of the 16 participants ranged from 27 years to 88 years. Half the participants were male. The participants were asked whether they had any disabilities and four people said that they had walking difficulties due to either arthritis or breathing problems. An additional three participants were wheelchair users who were manually pushed by another person.

5.2.2 Evaluation of the delineating strips

Figure 18 shows that strips 2 and 3 received the highest safety rating, both being rated as safe by 12 people.

All four of the participants with walking difficulties said that strip 8 was unsafe and three said that strips 2, 4, 6 and 9 were unsafe. Strip 7 was the only delineating strip that all four of the people with walking difficulties said was safe. All three wheelchair users felt that strips 1,2 and 7 were safe, and two thought strips 3, 4, 5, 7, 8 and 9 were safe to cross.

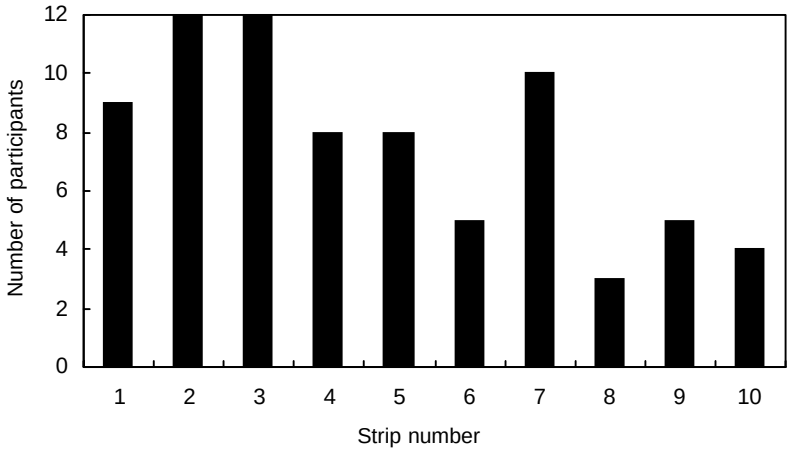

Figure 18 Number of participants rating delineating strips as safe

6 Maintenance of the delineating strips

Profile Line 1049.1

Strip 1 *12mm thermoplastic*
Initially the profile obtained was as laid out in Diagram 1049.1, however the material tended to 'slump' over time. Over four weeks, the surface slumped by about 2 mm.

The profile can cause drainage problems, but this may be overcome by providing sloping gaps at predetermined intervals.

Strip 2 *12mm blocks*
The concrete blocks are manufactured in the factory in preset moulds to give a uniform 1049.1 profile. The blocks can be manufactured in a variety of colours. If required, the blocks can be coated with an epoxy paint and ballotini beads to provide a white reflective surface.

Drainage would be a problem unless blocks were installed with a sloping edge at regular intervals.

Strip 3 *20 mm thermoplastic*
This strip had the same problems as the 12 mm profile in thermoplastic (strip 1), i.e. the material was prone to slumping and gaps would be required to prevent drainage problems.

Strip 4 *20 mm blocks*
The maintenance of this strip would be similar to that of strip No. 2. Blockleys have considered the drainage problem and can produce taper/end units to overcome this issue.

Strip 5 *Imprint*
The material tended to slump when laid hot and drag when too cold, leading to an uneven finish. The material has in the past been used to construct flat topped humps and is claimed to be hard wearing although the laying technique needs improving. Drainage is a problem with the material. The material is available in a range of colours, but not white, so would require spraying.

Experimental Profiles

Strip 6 *Raised Rib Line*
Although the preformed ribs were set onto the hot-applied thermoplastic, problems were experienced with maintaining this surface. During the trials, the ribs were knocked by the long canes, and some became dislodged. The strips were readily replaced, but this could prove costly over time.

As there were gaps between the ribs, water would not collect at the surface. However, silt etc. may build up against the ribs over time.

Strip 7 *Plastiroc*
The material has been used in France at zebra crossings and is claimed by the manufacturer to have a very long life.

Strip 8 *Horizontal Bars*
This strip suffered the same problems as strip 6 - i.e. the bars became dislodged during the trials. Drainage was a problem with the profile.

Strip 9 *Inverted T Shape*
The maintenance issues for this surface are similar to those for Strip 5.

Strip 10 *Flexitec Delineators*
The units did not butt up tightly as they have rounded ends. As they are straight and rigid, they would be difficult to lay on radii. The surface has been used in France and Germany on the carriageway to divide the vehicles from cyclists.

7 Views on shared use facilities

7.1 Visually impaired pedestrians

The visually impaired pedestrians were asked about their views and experiences of shared use facilities. Twenty-six participants (54 per cent) said they had never used shared segregated facilities, either because they did not need to use them or because none were available locally. Sixteen

participants (33 per cent) said they currently used shared, segregated routes. Six people (13 per cent) had used this type of facility in the past, of whom five either no longer had these facilities in the area they lived in or did not need to use them. The remaining person said that he had experienced problems staying on the pedestrian side and had been knocked over and injured by a cyclist.

The 16 participants who had used the facility were asked whether they had experienced any problems, see Table 4.

All pedestrians were asked whether they thought shared use facilities were safe or unsafe. Thirteen participants (27%) rated shared, segregated facilities as safe and just over half (54%) rated them as unsafe. Their comments are given in Table 5.

Table 4 Difficulties experienced with shared use routes, tabulated by frequency of use

	Usage frequency		
Difficulties using shared facilities	*Weekly (No.)*	*Less than weekly (No.)*	*Total (No.)*
None	2	1	3
Determining the start and end of facility	3	2	5
Staying on the pedestrian side	6	2	8
Cyclists staying on their side	4	5	9
Detecting the delineating strip or no strip being installed	3	3	6
Obstacles in the pedestrian path	2	0	2
Incorrect signing	1	0	1
Crossing the route to cross the road	1	1	2
Total (n)	9	7	16

Table 5 Comments on shared, segregated facilities

Comment	*Number of participants*
Worried about cyclists	26
It keeps pedestrians and cyclists separated	5
Prefer a physical barrier	4
Worried about keeping on pedestrian side	3
Needs a wide footway	3
Depends on type of delineating strip	2
Dangerous	2
Had no bad experiences	1

7.2 Cyclists

Thirty four cyclists (81 per cent) said they currently cycled on shared segregated routes. Seven of the eight participants who did not currently cycle on shared routes said that they had never used this type of facility. Of these, five said they did not need to cycle on them, one said the facility was not available in his area and one did not normally cycle. One cyclist said he used to use one but no longer did so because he had changed his route.

Twenty-one of the 34 participants (62 per cent) who currently used shared segregated facilities said that they had experienced difficulties when cycling on this type of path. However, many of their comments related to cycle routes more generally. Those comments that were particular to segregated, shared routes are given in Table 6.

The 42 participants were asked whether they thought shared segregated routes were safe or unsafe. Twenty-three participants (55 per cent) said that these facilities were safe, 13 people said that they were neither safe or unsafe or did not know, and six participants (14 per cent) said that they were unsafe. Their reasons are given in Table 7 which shows that some of those who rated the facility as safe qualified their answer.

Table 6 Difficulties using shared segregated routes (multiple responses possible)

Difficulty	*No.*
Pedestrians walking on the cyclists' side of the path	11
Pedestrians complaining about cyclists on the cyclist side of path	2
Too many cyclists coming from opposite direction on the correct side of path	1
Inability to see light signals	1
Parallel tactile markings are dangerous - push cycle over and cause loss of balance	1
Pedestrians and cyclists do not stay on their designated side	1
Where track ends on one side of the road and starts on the other	1
Total (n)	34

8 Discussion and recommendations

Five of the delineating strips tested in the project were laid in accordance with Diagram 1049.1 of the Traffic Signs and Regulations Directions. In two of these cases (strips 1 and 2), the delineating strips had a height of 12 mm, and the remaining three strips were laid to a height of 20 mm. It was found that the participants who had no useful vision were able to both detect and follow the higher profile of 20 mm without losing contact with the strip, and hence having to relocate it with their cane. In contrast, many of the participants with no useful vision lost contact with strips 1 and 2. However, similar numbers also found it difficult to maintain contact with strip 3 which comprised the 20 mm profile in the thermoplastic material currently used by local authorities when installing shared routes.

The brick and Imprint versions of the profile 1049.1 appeared to be easier for people to follow than the thermoplastic versions. This is demonstrated in the findings related to participants with useful residual vision, who were all able to follow both the 12 mm and 20 mm high brick and 20 mm high Imprint strips, but some were unable to follow both profiles of the thermoplastic strip. It appears that the brick at both heights and imprint materials performed better. This result was similar to that found with the participants who had some useful vision, where all the participants could follow strips 2 (12 mm brick), 4 (20 mm brick) and 5 (20 mm imprint), but some failed to follow the two thermoplastic profiles to the end of the 20 metres. It would thus appear that the thermoplastic material is less effective than the brick and imprint alternatives.

It has been reported by some local authorities that the thermoplastic material can lose its profile and height

Table 7 Reasons why shared segregated facilities are safe or unsafe

Difficulty	*Safe*	*Neither*	*Unsafe*
Depends on people's behaviour, i.e. whether they are responsible or not	3		1
Cyclists generally proceed with caution	1		
Most cyclists keep to their side of the path	1		3
Pedestrians walk in front of you	1		
In general safe but a small minority of cyclists ride without due care	2		
Safe - provided people keep to their sides	1		
Safe - due to visual barrier	2		
Safer than road	2		1
Only a problem if there are too many people	1		
Gives cyclists a path of their own away from cars and pedestrians	1		
People do not know what they mean	1	2	
They are not safe when the sides keep changing over all the time	1		
There should be different surfaces for each side	2		
Safe - provided built to standard and wide enough	2	1	
Not safe for pedestrians			2
Cars turn across you to get into their drives			1
Cyclist is encouraged to ride too fast			1
Pedestrians and cyclists should be kept apart			1
Prefer dedicated cycle lanes			1
More attractive than the road			1
Only safe if route does not cross a junction			1
You cannot see around corners			1
Provided both pedestrians and cyclists keep to their side	1		
Total (n)	23	6	13

('slumping'). Over the month this research was conducted, the material did slump by around 2 mm. If the surface is installed to a height of 12 mm, and the surface then slumps, it will not be able to serve its intended purpose of providing a tactile line between the cyclist and pedestrian sides of the route. However, if the surface is installed to a height of 20mm, it may still be fairly effective if it slumps by a couple of millimetres.

One of the reasons the DETR wished to re-examine the effectiveness of the prescribed profile was as a result of claims by some people using roller ball canes that the profile could not be detected when constructed in thermoplastic. The findings suggest that people using long canes with roller ball tips are more likely to lose contact with the current recommended profile of 12 mm in thermoplastic (strip 1) than those using canes with traditional tips. Just over half of the people using roller ball canes lost contact with strip 1 when trying to keep to one side of it, whereas only five per cent of participants using traditional tipped canes lost contact with it before following it to the end.

It seems likely that, as the thermoplastic material may slump, the users of roller ball canes fail to distinguish the strip from the surrounding footway which may be uneven. However, with the brick profiles (strips 2 and 4), the profile is pronounced with defined edges, and the cane users, including those using roller ball canes, seemed to be able to detect this fairly readily.

Strips 4 and 5 (20 mm brick and imprint) performed well with people using the traditional type of cane. Strip 5 had a rough surface in places, and this roughness seemed to help people locate the strip but at the same time meant that the cane occasionally became caught in the rough material. This material would however be an effective alternative to thermoplastic if the profile could have a smooth finish, as it is not prone to slumping and can be applied on top of the existing footway surface.

In terms of performance, therefore, the brick and imprint versions of the existing profile were superior to the thermoplastic, although the latter was fairly detectable where it had been laid as the higher profile of 20 mm. The cyclists generally preferred the lower profile, although around half rated the higher profiles as safe to cross.

Performance with the experimental profiles was mixed. Strip 7, the plastiroc material, was not readily detectable as its low profile meant it could not be distinguished from the surrounding footway material. However, the beads in the strip meant that people with some sight could detect the strip in good lighting conditions. This surface was not suitable for people who had no useful vision.

Those strips that consisted of horizontal bars (strips 6 and 8) caused problems for both pedestrians and cyclists. The cyclists commented that they were concerned about losing control of their bicycles. Many visually impaired people could follow the delineating strips, but only with difficulty because their canes tended to get caught on the bars, or, in the case of strip 6, go between the bars and so not detect the strip.

The inverted T shape (strip 9) performed fairly well but some did not feel it was pronounced enough and the upstand was likely to cause problems for cyclists and pedestrians.

To sum up, the existing profile (1049.1) was the best compromise between the needs of visually impaired pedestrians and cyclists, as found in the original research conducted by Williams (1987). As the profile has no vertical upstand, it can be traversed by cyclists in an emergency, yet its profile means that it can be readily detected by people with a visual impairment. It is recommended that the current profile be retained in the DETR guidelines, but with a preferred installation profile at 20 mm high.

The thermoplastic version of the profile was less

expensive than the brick and imprint materials, but it was less effective and prone to losing its profile and height. However, thermoplastic and imprint from the currently available materials would be most suitable where the delineating strip had to be installed on top of the footway. The cost of the brick versions is likely to prevent their wider use, especially on an asphalt or concrete surface where the surface would need to be cut out to allow the installation of the paviors.

In the past, rubber has been used to form the profile. However, this material was found to be prone to vandalism as it could be removed from the route surface. Other substantial materials, however, may be suitable.

Both the cyclists and visually impaired pedestrians had concerns about shared use routes. A third of the visually impaired participants said that they currently used this type of facility and most had experienced problems. The most frequently mentioned difficulties were staying on the pedestrian side, cyclists riding on the pedestrian side, detecting the delineating strip and determining the start and end of the facility. The current specification, 12 mm high thermoplastic delineating strip which is widely used, has been shown to be difficult to detect by some participants. It is likely that the incidence of these problems will be reduced if the 20 mm profile is installed in thermoplastic, or the 12 mm constructed in a different material. However, shared use routes will always create some difficulties for visually impaired people. They should not be the first option for separating cyclists from road vehicles, but should only be installed where other options are not possible.

The effectiveness of a delineating strip will partly be determined by the width of the footway. If the pedestrian side of the facility is too narrow to allow two pedestrians to pass, a person to work their guide dog, use a wheelchair or walk with a buggy, then pedestrians will occasionally need to cross the central delineator. Similarly, cyclists will need to cross the line if their side is too narrow to allow them to pass another cyclist, or if the pedestrian side is so narrow that pedestrians are entering the cyclist side. If the shared use route is designed with adequate widths, then there will be less need for pedestrians and cyclists to cross the delineating strip and the strip may be perceived as more effective in these situations.

9 References

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Hi Way Services	Manston Road, Ramsgate, Kent
Marshalls Mono	Southowram, Halifax, West Yorkshire.
Prismo Ltd	Gleneagles Court, Brighton Road, Crawley, West Sussex,.
Blockleys Brick Ltd	Sommerfied Road, Trench Lock, Telford.
Imprint Ltd	Hewels Farm Estate, Kingsfold, West Sussex.
BTM (Safety Products) Ltd	Fosseway, Midsomer Norton, Bath.

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Notes

[1] A further four guide dog owners who preferred not to participate with a long cane refused to take part in the trials as they felt their dogs would be unable to cope.

[2] A long cane is used to help people detect obstacles in their path. People are taught to either tap or sweep it across their body. A symbol cane is not used for mobility purposes, but gives an indication to others that a person has impaired vision. A guide cane is a mobility aid, and is held across the body. It may be used to keep contact with, for example, a kerb edge to help people keep in a straight path.

Abstract

Visually impaired pedestrians have reported problems with detecting the tactile central delineator used to separate cyclists from pedestrians on shared, segregated routes. This was reported to be due in part to the new types of long cane now used by a growing number of visually impaired people. This research tested the profile at the prescribed minimum and maximum heights (12 and 20 mm) with the existing thermoplastic material and other materials, together with five experimental profiles. The delineating strips were tested by visually impaired people, cyclists and other pedestrians. It was concluded that the existing profile can be detected when installed at a height of 20 mm especially when formed from block paviors or a material called 'imprint'.

Related publications

TRL141 *Experimental road crossing features for visually impaired pedestrians* by M C Edwards and T A Savill. 1995 (price code E)

TRL179 *Trials on platform edge tactile surfaces* by T Savill, G Davies, A Fowkes, C Gallon and B Simms. 1996 (price code H)

PR82 *Accidents involving visually impaired people using public transport or walking* by C Gallon, A Fowkes and M Edwards. 1995 (price code L)

CR257 *Tactile footway surfaces for the blind* by C Gallon, P Oxley and B Simms. 1991 (price code E)

CR317 *Tactile surfaces in the pedestrian environment: experiments in Wolverhampton* by C Gallon. 1992 (price code J)

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