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Working Paper 253

July 1988

**ERGONOMIC STANDARDS FOR PEDESTRIAN AREAS
FOR DISABLED PEOPLE**

Methodology and Sample Identification

B Berrett, G Leake, A D May, J Whelan

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This work was carried out under contract to TRRL.

ABSTRACT

This project is a TRRL research contract, the aim of which is to produce guidance on the design of pedestrian areas and footways for elderly and disabled people. The first part of the project was a literature review and consultation exercise, the objective of which was to identify key impediments for investigation. The second part of the project involved the detailed survey work on the key impediments. This Working Paper reports upon the development of the second part of the project and, in particular, upon the identification of the sample of disabled people to be used in the detailed interview and observation work.

The sample identification involved contacting some 3000 disabled people listed in official disability registers, and 250 able-bodied people via on-street interviews. From the disabled sample approximately 500 people were interviewed in order to find out more about their disability and to assess the usefulness of a preliminary disability categorisation system; their activity rate; problems they experience in using pedestrian areas and footways; and their willingness to take part in further stages of the study.

From the interviews, a sample of people in each of the revised categories, together with samples of the elderly and the able-bodied, were selected for an observation phase in which those involved were observed completing a movement distance exercise, and using different types of pedestrian facility, in central Leeds.

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1. INTRODUCTION

1.1 Study Objectives and Structure

1.1.1 The Institute for Transport Studies was invited by the Transport and Road Research Laboratory to submit a research proposal, with costs, aimed at establishing suitable "Ergonomic Standards for Pedestrian Areas for Disabled People". The project commenced on 1st July, 1986 and was split into two parts, with part one involving four months' work over the period to 31st December, 1986 and part two finishing on 30th April, 1988.

1.1.2 The main objectives of the Study laid down in the design brief by the Transport and Road Research Laboratory were:

- a) To produce a guide to good practice for the design and maintenance of footways and pedestrianised areas;
- b) To provide, where possible, recommended standards for design and maintenance.

The good practice guide and the recommended standards were to be primarily aimed at disabled people and the elderly, but the requirements of the able-bodied were also to be considered, as were conflicts between the needs of different groups of user. The economic implications of implementation and maintenance were also to be detailed.

1.1.3 It was agreed with TRRL that a two part programme was to be developed. The first was concerned with reviewing existing literature and standards on footways, pedestrianised areas and access to buildings. The second part was the development and execution of a survey instrument for identifying a sample of disabled people for in-depth investigation, including interviews and on-site observations, in order to determine the ergonomic requirements for disabled and elderly people on footways and in pedestrianised areas. Each stage of the study was discussed in detail with an Advisory Committee established for the purpose.

1.1.4 To meet these requirements it was proposed to conduct the study in the following stages:

- a) Contact and hold discussions with individuals and organisations involved or concerned with disabled people to identify priority issues for study;
- b) Conduct a short initial interview survey with 10% of the registered disabled in Leeds in order to obtain a sample for each of the five selected disability types for further study. In addition control samples of 50 elderly and able-bodied respondents would also be selected;
- c) Implement a physical survey of conditions in Leeds city centre to identify ranges of the individual impediments for further study;
- d) Carry out more detailed interviews with a sample of 50 to 60 from each disability-type in order to obtain perceptions and attitudes and to identify access-related barriers;

- e) Conduct detailed observations of the ability of the members of the sample populations of the disability types and samples of the elderly and able bodied to tackle a series of identified impediments in Leeds city centre;
- f) Conduct a brief follow-up interview with these same people to obtain their reactions to, and perceptions of, the on-site studies;
- g) Analyse the results and develop relationships and resulting guidelines.

1.2 The Philosophy Adopted

1.2.1 In developing the methodology it was necessary to adopt an approach to the treatment of the needs of disabled people which raised a series of philosophical issues and methodological assumptions. These were discussed in detail with the Advisory Committee before being adopted as a basis for the study.

1.2.2 Site-specific solutions The removal of impediments will cost money, and may impose problems for other users. The nature of these costs and problems will depend critically on the location. Modifying a level pedestrian low density site to meet the needs of disabled people will cost less than modifying the steeply sloping, constrained sites found in some town centres. Rather than recommending universal standards, the study aims to develop relationships between the scale of an impediment and the effects which it has on different disability groups. Such relationships should enable the designer to determine the implications of different levels of expenditure on the benefit to disabled users.

1.2.3 Catering for a range of disabilities There are a number of types of disability to be considered, and within any one disability category there is a wide range. Rather than assume, therefore, that the reduction of a particular impediment will benefit all who are disabled, the study aims to develop, for specific types of disability, a relationship between the scale of the impediment and the proportion of people having that particular disability who will be impeded.

1.2.4 Integration rather than special treatment One of the aims of the project is to assist in integrating disabled people into society. Hence the methodology is not necessarily trying to highlight some special status for the various groups of individuals who might be classed in this way.

1.2.5 Involvement rather than observation While the starting point for the study was an ergonomic one, it is particularly important to avoid simply observing disabled people and making judgements on their behalf. The study, therefore, has involved disabled people at all stages of the research, and incorporated their suggestions.

1.2.6 Improving accessibility It is assumed that disabled people wish to use pedestrian facilities but that there can be barriers or impediments which prevent them from doing so. The project is concerned with providing advice on how to overcome

these impediments. It focuses therefore on the accessibility of an area rather than its attractiveness. However, some of the reasons why disabled people use pedestrian areas were obtained during the detailed survey work.

1.2.7 Selectivity in study design The range of disabilities, impediments and potential study environments is wide, and consequently there was a danger that the limited study resources would be spread too thinly to be effective. It was, therefore, necessary to be selective. Consequently, priority was given to impediments considered to be both important and under-researched; to disabilities which could be studied using a common study methodology; and to a study area where the full range of impediments could be studied efficiently.

1.3 Selection of Impediments for Study

1.3.1 One purpose of the literature review and consultation process (Berrett et al, 1988a) was to identify impediments of concern to disabled and elderly people, and existing standards and guidelines for the avoidance of those impediments. The following types of impediment were identified:

- Parking provision and location
- Public transport
- Movement distance
- Surface conditions and type
- Road crossings and intersections
- Under- and over-passes
- Extensions to pedestrian areas
- Furniture
- Information provision
- Toilets
- Vegetation
- Drainage
- Steps at kerbs and buildings
- Stairs
- Ramps
- Handrails
- Lifts
- Escalators
- Doorways/entrance ways
- Insufficient plan consultation with disabled groups
- Shared-use with vehicles
- Weather

1.3.2 It was necessary to select a smaller number of impediments from the above list in order that they could be examined thoroughly. The consultation process was particularly useful, together with guidance from the Advisory Committee. As a result the following impediments were selected for further investigation.

- Movement distance
- Surface conditions
- Ramps
- Parking
- Public transport access

1.4 Selection of Categories of Disability for Study

1.4.1 It was recognised in the literature review (Berrett et al, 1988a) that the identification of disabled people poses many problems. Not only are sources limited and medically-oriented, but they can seriously underestimate the total number of disabled people. In addition to the problems associated with identifying disabled people from such sources, there is also the difficulty in identifying someone as being disabled, particularly those suffering from functional impairment.

1.4.2 A comparison of the various methods used to categorise disabled people was undertaken, from which it became clear that many classifications were currently used. Nine main categories were identified, namely:-

- 1) wheelchair users
- 2) activity impaired (e.g. through arthritis, angina)
- 3) ambulatory impaired (e.g. use of walking frames, crutches)
- 4) manipulatory impaired (restricted use of hands)
- 5) visually impaired
- 6) auditory impaired
- 7) mentally impaired
- 8) temporarily impaired (e.g. fractures)
- 9) encumbered (e.g. pushchairs, luggage).

1.4.3 Of these it seemed appropriate to concentrate on the first five, all of which have impairments which are readily identifiable. They also constitute the vast majority of permanently disabled people. The temporarily disabled present a further difficulty for study because of the problems of identification and because of the differences in people's reactions to temporary and permanent impairment. It was accepted, however, that these last four categories all merited further study, but that this was not possible within the resources initially available.

1.4.4 In practice the categorisations used were later changed in the light of the survey results and of the preparedness of those interviewed to participate in the observations.

1.5 Study Reports

1.5.1 This report describes the methodology adopted. Section 2 describes the screening interview. Section 3 describes the main interview. Section 4 describes the observation work.

1.5.2 Further reports in the series describe the literature review and initial consultation process (Berrett et al, 1988a); the results of the screening and main interviews (Berrett et al, 1988b); and the results of the observation studies (Berrett et al, 1988c).

2. THE SCREENING INTERVIEW

2.1 Introduction

2.1.1 It was recognised that the identification of disabled people poses many problems. Not only are sources limited and medically-oriented (Harris 1971), but they can seriously underestimate the total number of disabled people. In addition to the problems associated with identifying disabled people from such sources, there is also the difficulty in identifying someone as being disabled, particularly those suffering from functional impairment.

2.1.2 These problems were carefully considered when developing a suitable sampling approach. Accordingly the objectives of this element of the programme were identified as:

1. to assess the suitability of the various official disabled registers;
2. to obtain data from approximately 10% of the people on these registers so that a picture of the number of various types of functional disability could be developed, the activity pattern of the various individuals identified, and the problems they encounter examined; the identification of problems was a particularly important aspect of the study focus;
3. to obtain at least 250 people for further interview work and on-site observation.

2.2 Sample Selection

2.2.1 Ideally the selected samples should represent the range of disability to be found within each of the five selected disability types. It was decided that the most pragmatic approach would be to sample people from official sources. It was recognised that this would omit some disabled people who were not registered, but it was considered that to try to examine this population would require a disproportionate amount of the budget and the resources. The official sources used were the four registers held by Leeds City Council Social Services Department. The name of the registers and number of people on them are:

A.	Handicapped Register	(8,398)
B.	Blind Register	(2,759)
C.	Partially Sighted Register	(2,140)
D.	Orange Parking Badge Register	(11,554)

2.2.2 Each register was divided into nine districts (A-J) covering the whole of the Leeds Metropolitan Area. People were arranged alphabetically in the Handicapped, Blind and Partially-Sighted Registers. In the Orange Badge Register they were arranged by date of issue/re-issue of the badge.

2.2.3 Inevitably overlap exists, since some people will be on more than one register. For the Handicapped, Blind and Partially Sighted Registers this overlap was known, but the overlap between

these and the Orange Badge Register was not known. A computer programme was written to identify this overlap. In addition a modification was required to the sampling procedure as described in para 2.2.6.

2.2.4 The original plan was to interview approximately 10% of the registered disabled population, namely 1300 people, and it was upon this figure that resource implications were assessed. It was concluded, however, that it would be valuable to examine the Orange Badge Register directly, which meant that the overall sample would be less than 10%.

2.2.5 From other studies (Bailey and Layzell, 1981; Hoinville, 1984) a response rate in the region of 40% was expected. Therefore, to obtain 1300 favourable replies it was ideally necessary to sample approximately 3500 people from the Registers. This was to be achieved by selecting every seventh name from each district in each Register. Each person was to be initially contacted through a letter sent out by the Social Services Department outlining the purpose of the project and inviting them to participate. In practice a total of 2900 letters were sent out.

2.2.6 In the case of the Orange Badge sample there was a slight modification in the selection procedure. The sample identified for each district in the Orange Badge register was examined to see what proportion of people had an Orange Badge and were also on the Handicapped, Blind or Partially-Sighted Registers. The average was 20%. It was decided to send letters to all those who were on both the Orange Badge Register and one of the other Registers, and 10% of those who were on the Orange Badge Register only.

2.3 The Interview

2.3.1 The interview itself concentrated upon four aspects. Firstly, each individual assessed their disability according to a predetermined set of functional categories, derived as part of this project. A further series of questions obtained more insight into the particulars of their disability. Secondly, the purpose for which people move about outside was obtained together with the frequency with which they carry out these activities and the modes of transport they used. Thirdly, details of any problems faced in either getting to or moving around the central area of Leeds and their local centre was obtained. Finally, each person was asked if they would be willing to take part in a further interview and some observation work in the centre of Leeds.

2.3.2 The interview form was piloted on five individuals: one wheelchair user, three ambulatory disabled and one visually handicapped person. The interview method proved generally successful, but it was realised as a result that show cards were needed, and that more time than anticipated was needed to complete the interview. The pilot respondents had not been selected as part of the sample, and their responses were not therefore included in the final results.

2.3.3 The finally adopted interview form is included as an

appendix to Berrett et al (1988b).

2.4 The Response

2.4.1 The response to the contact letter was 842 returns or 29%. However, 292, or 10% of people sampled, were known to have either moved, were in hospital, had died or that their recorded address was inadequate or incorrect. Removing these figures from the calculation produces a response rate of 32%.

2.4.2 Of the 842 responses to the contact letter 649 were favourable (77%), from which it was possible to interview 494 (76%). The reason the 649 were not interviewed was that it was either not possible to contact people by telephone or by housecalls, or that they had gone into hospital, felt too ill to answer the questions, or they had moved subsequent to the sample identification interview. Although the original aim was to interview 1300 people, the 494 interviewed did provide a sufficiently wide base from which to select the 250 people for the observation study and the main "before" interview. In addition 25 people were interviewed at two Day Centres in Leeds to assess the overlap between this possible source of participants and the sample frame used.

3. THE MAIN INTERVIEW

3.1 The Interview

3.1.1 Based on the screening interview, a more detailed interview was planned to provide greater insight into the problems elderly and disabled people face when using pedestrian areas and footways. The interview was also designed to obtain an assessment of the severity of these problems, and to identify useful sites within central Leeds for the observation work. The disability categorisation system was also tested during this interview.

3.1.2 A pilot survey was carried out in May 1987 with 25 people. These people were obtained from each of five disability groupings (wheelchair users, severely ambulatory disabled, moderately ambulatory disabled, slightly ambulatory disabled and visually handicapped), with five people in each group. The interview was semi-structured and took approximately 30 minutes to complete and comprised three main sections.

3.1.3 In the first section, background data was collected on places visited, mode of transport used, frequency of travel, and any problems encountered in getting to and moving around the city centre and local area. Secondly, more detailed information was obtained upon the impediments which were of particular concern in this project. These included parking, access, surface conditions, ramps, crossing the road, and information provision. Each person was also asked to assess the severity of the problems encountered on a five point scale. Finally, each person was asked to agree to participate in the observation exercise.

3.1.4 The pilot survey indicated that a person's self-assessment of their disability remained consistent between interviews and could be used as a reasonable means of analysing data from the full interview and in selecting people for the observation work.

3.1.5 In light of the findings of the pilot survey, the interview was modified, primarily involving the reordering of questions and the omission of less essential questions. The final version of the interview form is included as an appendix in Berrett et al (1988b).

3.2 The Interview Sample

3.2.1 Respondents to the screening interview gave the following breakdown in terms of their need for aids:

Wheelchair users	90
Ambulatory with aid	185
Manipulatory impaired	8
Blind and Partially sighted	55
Ambulatory without aid	150
Other	3
No response	3

3.2.2 The sample of respondents to the main interview were self-categorised as:

Wheelchair users	55
Slight Ambulatory disabled	99
Severe Ambulatory disabled	73
Visually Handicapped	45
Other	13

The main interview respondents were selected on the basis of their prior agreement to take part in the second interview. It was necessary to attempt to approach all those who agreed to the second interview because of problems of re-contact, people going into hospital, and the need for a safety margin of numbers of respondents.

4. OBSERVATION WORK

4.1 The Pilot

4.1.1 A major element of the project was the on-site observation work from which the empirical evidence for the design guidance could be drawn. It was considered essential that this part of the programme should be carefully piloted, not only to ensure that the programme was feasible, but also to provide training experience for the survey staff before the major survey work commenced.

4.1.2 The pilot survey took place during June 1987 and was primarily concerned with the impediments created by movement distance, surface conditions, public transport waiting areas, and ramps. The same interviewers used in the main interview were used in the pilot of the observation work. A St John's Ambulance Officer was also in attendance at all times, and portable seating and wheelchairs were always on-hand during the on-site work.

4.1.3 Three main survey techniques were used for obtaining the on-site information. The first was to have the survey staff recording, directly onto tape, information such as the time taken, distance travelled, pauses and their duration, and awkward manoeuvres. The second was to use pen and paper to obtain the same data. The third technique used was the use of video-recordings at particular locations.

4.1.4 Each group of disabled people comprised five participants with the same disability, although some experimentation with mixed grouping took place. Each group was accompanied by two survey staff and the St John's Ambulance Officer, and were involved in survey activities for no more than 120 minutes.

4.1.5 One group of participants at a time was taken to central Leeds by minibus, organised in co-operation with the Leeds City Council Social Services Department and West Yorkshire PTE. After being dropped off at various locations, each group was taken along a particular route to a refreshment centre. This element of the on-site work was used primarily as the movement distance exercise. Immediate reactions to the exercise were recorded by the survey staff during this rest period. Each group was then taken along a route and stopped at particular locations along the route in order to obtain their assessment of surface conditions, ramps and public transport waiting areas. Each group was then picked up and individuals taken back home.

4.1.6 The data collected on the impediments and the manner in which this was done is set out below:

<u>Impediment</u>	<u>Characteristic Examined</u>	<u>Method</u>
1. Movement Distance	Distance moved Time taken to move Rest period Problems	Video and tape Video, tape, pen and paper Tape, video, pen and paper Tape, pen and paper
2. Surface Conditions	Gradients - observable aspects Gradients - assessment of problem Camber Evenness	Tape and video Tape, pen and paper as above as above
3. Ramps	as surface conditions with the addition of: Time taken to move Distance moved	Video, tape, pen and paper Video, tape
4. Public Transport Waiting Areas	Problems Assessment of conditions	Tape, pen and paper as above

4.1.7 Two kinds of analysis were conducted. Firstly there was an assessment of the usefulness of the data obtained from video, tape, and pen and paper activities. This sought to establish whether the data provided any real insight into the problems people were experiencing, and which could provide quantifiable measures of these problems. Clearly, if no problems were observed or mentioned then the survey instrument needed revising, particularly in the light of the data that was obtained from the sample identification interview, and the pilot before interview.

4.1.8 Secondly, the operational aspects of the exercise were studied. This concentrated on the most appropriate group size, the logistics of bringing people in/taking them home, refreshment locations, and site selection. It was obviously important to examine what was realistically possible and how the approach proposed needed to be adapted in order to maximize the quality of the data collection exercise and minimise the potential strain upon the participants. These points are discussed below.

4.1.9 Movement Distances Differences emerged between the groups regarding the time it took people to move over distances, as well as the distances people were willing/able to walk. The importance of selecting an appropriate route length and course was also clearly illustrated. It was also found necessary to devise techniques for keeping people within a group disparate during the exercise; e.g. by starting people at different times

after indicating the route to be followed. It was essential to discuss each activity as soon as it had been completed, since neither the analysis of the video, nor tape or pen and paper methods carried out during the activity adequately revealed if people were pushing themselves too much.

4.1.10 Surface Conditions This part of the study was carried out after the walking distance exercise and after a rest period. From interviewing people at the end of this activity it appeared that this sequence of events had not been making unreasonable demands upon people's stamina. The results that emerged revealed a reasonable spread of assessments of the severity of particular surface condition problems and of the particular aspects that caused the problems. It was also clear that careful consideration needed to be given to the sites to be examined in order to obtain a range of impediment assessments. The distinction between gradient, camber, evenness and friction appeared justified as people gave different assessments to such aspects at a particular site.

4.1.11 The operational aspects of the pilot survey provided much useful experience. Considering the data capture techniques, it seemed realistic to collect data by pen and paper, tape recorder and video camera but after certain revisions. These were that the interviewers would only use one of these techniques at a time. Thus, the tape recorder was to be used for the movement distance element; the pen and paper technique for surface conditions, public transport waiting area and ramps; and the video-recorder was to be used during the activities. This meant that only two survey staff were usually needed, along with the medical assistant. It also seemed sensible to have groups of four or five people rather than the ten originally planned, since this could be adequately dealt with by the interviewers. Transportation into the area was successfully carried out with experience suggesting the use of a four-door estate car for most people, and the Access Bus for wheelchair users.

4.2 Sample Selections

4.2.1 In the light of experience with the main interview, it was decided to reclassify the types of disability being studied as:-

- wheelchair users
- severely ambulatory disabled
- moderated ambulatory disabled
- slightly ambulatory disabled
- visually handicapped

The aim was to obtain approximately 50 people in each disability group.

4.2.2 The main interview sample provided this for most categories, but it was evident during re-contact that not all of these would be able to be involved. Some could not be re-contacted; some refused to participate after initially agreeing to do so; some agreed but did not in practice arrive on the day. It was therefore necessary to approach others who had been contacted during the screening interview and, in the case of the

visually handicapped, some who had not previously been involved.

4.2.3 The recategorisation of ambulatory disability was largely based on responses to the main and screening interviews. Where necessary further categorisation was carried out on site before the observation work was conducted. In a few cases people who had specified that they used one type of aid arrived using another, and were recategorised. The broad categorisations were as follows:-

Severe: two walking sticks, crutches, zimmer frame;

Moderate: one or two walking sticks, elbow crutch;

Minor: one walking stick, or no aid.

The categorisation of individuals to these groups was checked against the interview and observation details on completion of the full exercise, and no significant adjustments were found to be necessary.

4.2.4 Table 4.1 indicates the relationship between those observed and those interviewed in the main interview. Of the 47 wheelchair users observed, five had been recategorised, and 18 were not involved in the main interview. Among the 46 visually handicapped, two had been recategorised, but 36 were not involved in the main interview. The ambulatory disabled were almost all people who had been interviewed, but considerable recategorisation took place between interview and observation.

Table 4.1

Comparison of Disability Types in the Main Interviews and Observations

Main Interview Category	<u>Observation Category</u>				
	Wheel-chair	Ambulatory Severe	Ambulatory Moderate	Ambulatory Minor	Visually H'capped
Wheelchair	24	1	0	1	0
Use stick/cane	2	17	30	15	1
Limited Walking ability	3	8	18	27	1
Visually handicapped	0	0	0	1	8
Other	0	3	2	1	0
Not interviewed	18	12	4	3	36
Total	47	41	54	48	46

4.2.5 In addition, a sample of 52 elderly people was selected for observation. The main source for the sample was social centres in Leeds. With the agreement of the centre managers, interview staff visited the centres and selected a sample of those who were not themselves disabled.

4.2.6 Finally, an able-bodied sample was drawn from among pedestrians in Leeds city centre, who were not elderly or obviously disabled. An attempt was made to select the sample to represent the distribution of sexes, age groups and degree of encumbrance in the pedestrian population. Some difficulty was encountered in finding people willing to devote the time to the observation work and only 38 able-bodied people were involved in the survey.

4.3 THE MAIN OBSERVATION WORK

4.3.1 The main observation work took place in September and October 1987. The observation of the sample of able-bodied participants took place in January 1988.

4.3.2 Groups of four or five participants at a time were brought, by a private transport company specialising in transport for elderly and disabled people, to a central point in Leeds. Participants were invited so that all members of any particular group had broadly the same type and severity of disability. A

St John Ambulance attendant was present throughout the observation work.

4.3.3 From the central point, at the junction of Lands Lane and Albion Place, participants took part in a movement distance exercise, which was followed by refreshments. After refreshment, participants travelled along one of two routes to make assessments of surface conditions. The route ended back at the central point, where participants were collected, and returned home.

4.3.4 In the movement distance study all participants travelled over a route of nearly 200 metres with no planned break. Timings were taken at various intermediate stages, note taken of participants' pauses for rest, and participants' pulse rates were recorded before and after the exercise. Participants were also asked a variety of questions, including questions aimed at assessing their fatigue. A combination of tape recordings and interview forms were used to record information for later analysis. Video recordings were also taken, as far as was practical, of participants as they travelled along the route.

4.3.5 After refreshments each group was taken along one of two routes that led back to the central point. One of the routes was considerably shorter than the other and participants who research staff suspected might not have been able to manage the longer route were taken along the shorter route. The groups were stopped at intervals of approximately 30 metres or when a particular design feature had been traversed and were asked a series of questions relating to the area they had just moved across.

4.3.6 There were eight aspects covered, namely:-

- 1) Slope/Gradient
- 2) Camber
- 3) Grip
- 4) Gaps between pavers
- 5) Height between pavers
- 6) Width of pavement
- 7) Other aspects
- 8) Fatigue

The duration of the periods of movement were also recorded by the interviewers.

4.3.7 At regular intervals during the exercise participants pulse-rates were monitored by the St John's attendant. This allowed early recognition to be made of excessive demands being placed upon participants. Mobile seating was kept on-hand to cope with participants wishing to rest before arriving back at the arrival point at which the vehicle was waiting.

4.3.8 A number of participants who were willing to undertake further work were taken round a short extension route to obtain some further surface conditions information.

4.4 Site Measurement

4.4.1 Length A measuring wheel was used to record the length of the route sections, and those parts of the route sections associated with ramps.

4.4.2 Skid Resistance A portable skid resistance tester, as described in Road Note 27 (HMSO, 1969) was used. Readings were taken at two sample sites along each section of route, each sample site chosen to represent a typical surface found along the route section. The procedure for testing was as described in Road Note 27. This method was not entirely appropriate as the skid tester simulates sliding between vehicle tyre and road surface at 50 km/hr. It was however, a practical option, particularly since most authorities will either have, or have access to, such a skid resistance tester.

4.4.3 Gaps A gap was defined as having a minimum width of 20 mm and depth of 5 mm. In practice an element of judgement was required to interpret the definition where the gaps do not totally fulfil the requirements. To find the gaps to be recorded a length of cotton was laid out and tightened following the route taken by participants. A close examination of the ground immediately under the line of the cotton was made, and where a gap was found it was categorised and recorded. The number of gaps of 20-30 mm, 30-40 mm and greater than 40 mm were recorded, as was the direction of the gap.

4.4.4 Height Displacements Two methods were followed to get a measure of height displacement of pavers.

- (i) A length of cotton was laid out and tightened over over the route followed by participants. A close examination of the ground immediately under the cotton was made and notes made of all height displacements of greater than 5 mm. Kerbs were not included. The displacement was categorised into 5-10 mm, 10-15 mm, 15-20 mm, 20-25 mm, and > 25 mm groups. Judgement was sometimes needed to decide into which category a height displacement would fall, or whether to include a discontinuity as a height displacement.
- (ii) The second method took a completely different approach, and did not concentrate on measurements of lips which could cause respondents to trip, but compared small samples of the route sections to an hypothetical plane fitted to match the slope of the sampled sites. A rectangular grid 5m x 2m with nodes at 0.5m intervals was laid out over specimen areas in chalk in the direction in which the participants travelled. The specimen areas were those judged by eye to be the most uneven areas to be found on parts of the route section

over which participants typically moved. Two grids were laid out for each section of route. Using a laser levelling device the variation of each of the nodes from an hypothetical horizontal plane was found. With the aid of a computer another hypothetical plane was generated which provided the best fit to the grid data using the method of least squares. The mean absolute deviation of the nodes from the fitted plane was then found and used as a measure of height displacement.

4.4.5 Camber As the grids described above were laid out with their long side parallel to the direction of passage, the nodes situated on the two long sides of each grid could be compared to each other to give an average measure of camber within the grid.

4.4.6 Gradient Gradients along the route sections were measured by clinometer; lengths of each part of route section with different gradients were found using a measuring wheel. The gradients used in the analyses were the steepest found in each route section.

5. CONCLUSIONS

5.1 The sample identification element was a particularly interesting exercise, which provided many useful conclusions. Firstly, the official Disability Registers appear to be a usable sample frame, but they do have limitations. These primarily lie in the accuracy of the Handicapped, Blind and Partially Sighted Registers. The Orange Badge Register is generally more accurate given the up-dating mechanism involved in the Orange Badge Scheme. However, it was evident from the results that the use of only one of these Registers could provide a potentially biased sample. For example the Orange Badge users tended to be more active members of society in terms of participation in the outside environment. The other Registers, however, contained many severely disabled people who did not have as great a participation rate as Orange Badge Holders, but who nevertheless felt that improvements to pedestrianised areas would help them to participate more frequently.

5.2 The sample identification phase took longer than anticipated to complete. In part this was due to the exploratory nature of the research, but also to the inaccuracy of the Registers which required booster sampling part-way through the programme. Such an eventuality had been allowed for in the research programme.

5.3 The sample identification phase also did not achieve the 1300 interviews originally intended. Again, the reasons are related to the above, but it ought also to be noted that the 600 people actually interviewed were found to provide an acceptable base from which to select the 250 for detailed on-site work. This, it must be remembered, was the primary purpose of the sample identification phase.

5.4 The detailed interview with the selected sample of 250 was successful. It provided valuable data on the type and severity of problems the key impediments identified raised, and locations within Leeds at which they did so.

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