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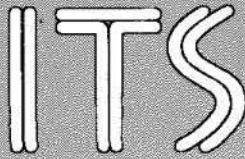Institute of Transport Studies

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DETERMINATION OF PRIORITIES FOR FOOTWAY RECONSTRUCTION

G R Leake, A D May and T Parry

Abstract

This report describes a study conducted for Sheffield City Council to obtain pedestrians' reactions to the quality and acceptability of footways of different construction in different conditions, and to assess pedestrians' preferences for different types of footway construction. The results are intended to aid the Council in identifying priorities for the maintenance of existing footways, and preferred surfaces for new or reconstructed footways. The study involved four stages; a new survey to identify footway characteristics of concern to pedestrians; interviews and objective measurements at a total of 13 sites; interviews at a set of eight purpose built trial sites; and analysis and interpretation of the results.

CONTENTS

1. INTRODUCTION

1.1 STUDY OBJECTIVES

This Working Paper presents the results of a study for Sheffield City Council, whose main objectives were:

1) to obtain pedestrians' reactions to the quality and acceptability of footways of different construction in different conditions;
2) to assess pedestrians' preferences for different types of footway construction;
3) to assess at what stage the footway became unacceptable to the user, and hence required maintenance or reconstruction.

It was intended that the results would be used, together with work which Sheffield City Council are conducting, to identify priorities for the improvement of existing footways, and preferred surfaces for reconstructed or new footways.

The study was restricted to footways alongside roads, and excluded defects caused by trees, impediments such as street furniture and kerbs, and the effects of rain, ice and darkness. It focused specifically on the four main types of surface found within the city:

a) Black top
b) Conventional large flags
c) Small element flags
d) Block paving.

1.2 STUDY METHOD

The study method was developed in an earlier contract commissioned in December 1988. The report of that contract (Leake and May, 1989) specified a four stage process which was accepted and adopted for the main study. The four stages were:

1) identification of the characteristics of concern to pedestrians;
2) determination of attitudes to different (measured) values of each of these characteristics;
3) determination of attitudes to well constructed footways of different types;
4) analysis and interpretation of results.

Stage 1 involved conducting an interview with pedestrians, and enabled them to identify, in their own words, the issues of

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concern to them as pedestrians and, within these, any aspects of the footways on which they were interviewed which they liked or disliked. A total of 59 interviews were conducted at two sites, with the interviewees selected from both sexes and from the four groups of pedestrians whom it was considered appropriate to survey:

1   young mobile ($\leq$50 years old, without a walking aid);
2   elderly mobile (>50 years old, without a walking aid);
3   disadvantaged; disabled (having an aid to walking, in a wheelchair, visually handicapped);
4   disadvantaged; encumbered (pushing prams, carrying luggage, with children).

Stage 2 was designed on the basis of answers to Stage 1 and of earlier work for TRRL (Berrett et al, 1988; Berrett et al, 1989). It was originally intended to include 14 sites chosen to represent three different conditions for each of the four surface types, together with two sites on steeper gradients than normally found. In practice it was not possible to find a block paving site in poor condition. Consequently only 13 sites were surveyed, with the two gradient sites being replaced by two which enabled "within site" comparisons of surface types to be made. At each of the sites, a total of 120 interviews was attempted, consisting of 30 from each of the groups 1 to 4 above. Objective measures of site conditions were also made. For Stage 3 Sheffield City Council constructed eight trial areas of footway on one site, each area having a different type of surface. A total of 186 pedestrians, again drawn from the above four groups of user, were interviewed to ascertain their assessment of the surface condition and of its potential visual acceptability in different settings.

1.3 REPORT OUTLINE

Section 2 of this report describes the methods adopted in more detail, and presents the results of Stage 1, on which Stage 2 was designed.

Section 3 presents the results of Stage 2 and develops a series of guidelines for determining the need for remedial action for different surface types.

Section 4 presents the results of Stage 3 and conclusions on the relative acceptability of different surface types.

Section 5 provides both an executive summary of the study and the main conclusions.

2. METHOD

2.1 OVERALL APPROACH

2.1.1 The study approach had four main stages:

Stage 1   Identification of the characteristics of concern to pedestrians - this was considered to be essential if the study was to focus on those characteristics identified by pedestrians as being of concern, rather than on those considered important by the researchers.

Stage 2   Determination of pedestrians' attitudes to measured values of the characteristics of concern. To do this it was necessary to identify sites with high pedestrian activity and a range of footway conditions.

Stage 3   Determination of attitudes to well-constructed footways of different types.

Stage 4   Analysis and interpretation of the results obtained.

Stages 1-3 are now described more fully.

2.2 STAGE 1

Stage 1, which aimed to focus on characteristics which pedestrians identified as being of concern, was undertaken using a questionnaire technique with an open-ended set of questions. It was piloted in Leeds, with the main run being conducted at two sites in Sheffield. The interview form used in Sheffield is shown in Appendix A. The detailed results are given in Tables 2.1 - 2.9.

The interviewing was conducted on Friday 30 June 1989; 39 interviews were conducted in the City Centre on The Moor, and 20 interviews were conducted at Manor Top, a shopping area out of the City Centre. Passers-by were approached and asked if they would agree to being interviewed. No reference was made to the exact purpose of the interview. Consequently there was no indication that the investigation was concerned with footways or their condition.

Pedestrians have a wide range of abilities and it was considered necessary to take this variation into account. A question to place each pedestrian into one of the four chosen categories was piloted in Stage 1, and subsequently used.

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Although the categorisation was simple, it ensured that a broad spectrum of respondents would be included in the research. As indicated in Section 1 these categories were:

- Young mobile (≤ 50 years old);
- Elderly mobile (> 50 years old);
- Disadvantaged (disabled);
- Disadvantaged (encumbered).

Basic respondent details are given in Table 2.1, and are broadly in line with the results found in the earlier TRRL study. It will be noted that in this initial work a detailed breakdown of age was obtained.

TABLE 2.1 STAGE 1 BASIC DETAILS OF SAMPLE.

Total number of interviewees   59

Sex	Male	30%
	Female	70%
Age	less than 21 yrs	5%
	21 - 30 yrs	22%
	31 - 40 yrs	20%
	41 - 50 yrs	10%
	51 - 60 yrs	12%
	61 - 70 yrs	17%
	more than 70 yrs	14%

Group

1	Young mobile (≤ 50 years old)	22%
2	Elderly mobile (> 50 years old)	29%
3	Disadvantaged (disabled)	25%
4	Disadvantaged (encumbered)	24%

The street features that interviewees reported as being helpful are given in Table 2.2.

TABLE 2.2 FEATURES OF HELP TO RESPONDENTS

	No of responses
No traffic	6
No cars on the precincts (safer to walk about)	4
Plenty of seating; dropped kerbs	2
Good transport; shops near to each other; cycle parks; good footways; good pavements; good flags; underpass; drops from pavement to road; no road for cars in shopping areas; benches to sit on; flat	1 each

Interviewees were also asked to itemise those street features that hindered them. The results are shown in Table 2.3. It should be noted that the statements are the interviewees' own comments, and that the references to "pavers" indicate small element flags.

TABLE 2.3   FEATURES OF HINDRANCE TO RESPONDENTS

	No of responses
Broken pavers	8
Uneven/bumpy pavers	7
Crowds	5
Holes in pavers; state of pavement; pavers wanting repair; kerbstones too high	3 each
Lack of ramps; market stalls; traffic in precincts; parked cars; rubbish on streets	2 each
Sticking up pavement; steps; small bricks; small paving stones; grid round trees; space between market stalls; adverts outside shops; not enough seating; traffic too congested; lack of direction signs; pavers; dog muck; one-way streets.	1 each

Respondents were also asked to identify the best area in the immediate vicinity. In the City Centre there was a choice of areas constructed of block paving, small element flags or large flags in the immediate surroundings. Table 2.4 indicates the results obtained.

TABLE 2.4 BEST AREA - CITY CENTRE

	No of responses
Block paving	16
Small element flags	13
Conventional large flags	4
None stated	6

At Manor Top the main area was black top and included one privately maintained area in poor condition. There were also smaller areas of small element flags and large flags. Table 2.5 indicates the results obtained.

TABLE 2.5 BEST AREA - MANOR TOP

	No of responses
Small element flags	6
Concrete	2
Black top	5
Conventional large flags	1
None stated	6

Respondents were also asked to identify the worst area in the immediate vicinity. Tables 2.6 and 2.7 indicate the results obtained.

TABLE 2.6 WORST AREA - CITY CENTRE

	No of responses
Conventional large flags	17
Block paving	9
Small element flags	6
None stated	7

TABLE 2.7 WORST AREA - MANOR TOP

	No of responses
Black top	14
Small element flags	2
Conventional large flags	1
None stated	3

Respondents were also asked to indicate what made the "good areas" satisfactory. The stated qualities are set out in Table 2.8 and are categorised by surfacing material.

TABLE 2.8 QUALITIES OF "GOOD" AREAS

Number of responses

	Black Top	Small Element Flags	Conventional Large Flags	Block Paving
Level	11	6	3	5
Not patched	7			
Easy to walk on	1	4		4
No holes	1	1		
Easy to push pram on	1	1		
Not liable to crack or lift like a flag	1			3
Modern and neat looking		4		
Easy to repair		3		
Not as many cracks or gaps		8	2	
No loose slabs		1		
Heels do not get stuck		1	1	
Not broken			2	
Not dangerous			1	
Good grip				5
More gaps, so more grip for sticks				1
Attractive				6

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Respondents were also asked what made the "bad areas" unsatisfactory. The replies are set out in Table 2.9 and are again categorised by surfacing material.

TABLE 2.9 QUALITIES OF "POOR" AREAS

	Number of responses			
	Black Top	Small Element Flags	Conventional Large Flags	Block Paving
Cracked	7	7	12	
Uneven	4	2	12	
Raised edges		1	2	
Gaps between pavers		1	2	5
Difficult or dangerous to walk/wheelchair on	2	1	6	3
Pram wheels/Heels/stick get stuck			2	1
Bumpy			3	3
Too many joints or places to catch your heel				4
Coming apart				2
Can be slippery		1		
Paving slopes down to road		3		
Flags rocking		3		
Holes/Puddles	8			

The results of Stage 1 reveal that when respondents were asked to indicate features hindering their progress (with no reference made to footways by the interviewers), problems with footways were frequently mentioned by respondents. From the answers received, those footway problems found to be of prime concern, and hence included in the detailed Stage 2 of the work, were:

- overall difficulty or danger (representing concern for the totality of problems which may be encountered, rather than particular characteristics of surfacings);
- elements that were broken or cracked;
- gaps between adjacent elements;
- general unevenness of the surface;
- quality of repairs;
- raised or tilted elements, resulting in upstands;
- slipperiness of surfacing.

2.3 STAGE 2

The main objective of Stage 2 was to obtain the reaction of pedestrians to the quality of different types of exisiting footway, with a view to determining acceptable standards of maintenance, and hence enable the officers of Sheffield City Council to determine when the standard of a particular footway had deteriorated sufficiently for maintenance or re-construction to be necessitated.

As indicated above, Stage 1 was carried out in order to identify the main characteristics of concern to pedestrians using footways. This resulted in five footway characteristics (variables) being identified as being most important and hence needing detailed investigation, namely:

(a)   Undulation
(b)   Raised edges
(c)   Friction
(d)   Broken pavers
(e)   Gaps between pavers.

These are defined more fully in Appendix B.

It was agreed originally that 14 sites should be studied to give a spread of different surfacing materials and conditions, with three areas within each site. Previous work in Leeds had indicated that an area 10m x 2m would be sufficiently large for interviewees to assess it as an entity, without being too large for ease of physical measurement. A short list of potential sites was drawn up by the officers of Sheffield City Council and each site was visited and assessed for suitability. The criteria for selection were:

- the sites had to be busy enough to find sufficient respondents, but not so busy that interviewing would be difficult;
- it had to be possible to mark out three 10m x 2 m areas in close proximity to each other, with one of the areas in relatively poor condition, another in fair condition, and a third in good condition.

As a result of the site visits, 13 suitable sites were chosen (see Table 2.10). As will be seen only two block paving sites were available in Sheffield. Efforts were made to locate an additional site outside Sheffield, but were unsuccessful. Two of the sites contained a mixture of surfacing types. A photograph of each of the sites is shown in Appendix C.

TABLE 2.10   LIST OF SELECTED SITES

Type	Location	Site Number
Block	Moor/Fitzwilliam Gate	2
Paving	Moor (Marks & Spencers)	3
Small	Pinstone St	1
Element	Fitzalan Sq (GPO)	15
Flags	Langsett Road/	
	Hillsborough	7
Conventional	Manor Top	5
Large Flags	Chesterfield Road	
	(Fashion Focus)	13
	Ecclesall Road	6
Black Top	Darnall	11
	Manor Top	4
	Chesterfield Road	
	(Tesco)	12
Mixed	West Street	9
	Moor/Fitzwilliam Gate	8

The questionnaire (See Appendix A) was developed from the findings of Stage 1. Details of the respondents were recorded so that analysis could reveal any differences between categories of pedestrian, and as a check that a representative sample had been obtained. The interviewer's name was also recorded to check for any interviewer bias. The questions relating to footway quality were phrased as statements to which the respondent was asked to agree or disagree.

To avoid the possibility of bias occurring due to interviewees having a tendency to agree with statements about the footway areas, two versions of the questionnaire were used, in which the statements were phrased with opposite meanings. For example, in Version 1 of the survey form (Question 7) respondents were asked how strongly they agreed or disagreed "that the marked area is not difficult or dangerous to walk on", while in Version 2 respondents were asked how strongly they agreed or disagreed "that the marked area is difficult or dangerous to walk on." If there was a tendency to agree with statements, this would become apparent in the analysis. The order in which the three areas within a site were presented to the interviewees was also varied.

It was intended to select 30 respondents at random for each of the four selected ability groups at each site. To conduct the

interviews, experienced interviewers were employed. They were
briefed on the objectives of the research, and the function of
individual questions. Since the wording of the two versions
of the questionnaire was similar, but opposite in meaning,
interviewers generally used one of the versions only, to avoid
confusion. Interviewers were given a daily target of 32
interviews to complete, eight within each of the Ability
groups.

Interviews were conducted over two time periods. Most of the
interviews were conducted during the period 10 - 21 July 1989,
and occupied 59 interviewer days. The remaining interviews
were conducted in the period 18 - 21 September 1989, a total
of 6 interviewer days. The weather during the two periods of
interviews was fine. Between 118 and 131 respondents were
interviewed at each site, with a minimum of 25 respondents in
any of the Ability groups. Basic respondent details are given
in Table 2.11.

TABLE 2.11   STAGE 2   BASIC DETAILS OF SAMPLE

Total number of interviewees = 1650

| Sex | Male | 31% |
| | Female | 69% |

Age	less than 21 yrs	8%
	21 - 30 yrs	21%
	31 - 40 yrs	13%
	41 - 50 yrs	12%
	51 - 60 yrs	12%
	61 - 70 yrs	19%
	more than 70 yrs	15%

Group

1	Young mobile ($\leq$ 50 years old)	26%
2	Elderly mobile (> 50 years old)	25%
3	Disadvantaged (disabled)	24%
4	Disadvantaged (encumbered)	25%

Once the sites had been agreed upon and the areas marked out,
measurements of the characteristics of the areas within the
sites were taken, so that the objective measurements could be
related to the degree of difficulty expressed by respondents.
The area characteristics measured were:-

(a)   -   degree of undulation;

(b)   -   length of raised edges in three bands:-
            >5mm, >10mm, >15mm;

(c)   –   frictional resistance of the surfacing material;

(d)   –   percentage of broken elements;

(e)   –   length of gaps between elements in four bands: >5mm,
            >10mm, >15mm, >20mm.

It should be noted that only (a) and (c) applied to black top
sites.

The characteristics of the marked areas that were measured,
and the methods of measurement, were based on work conducted
in Leeds as described in Berrett et al (1988 and 1989). The
method of measuring and recording each of these
characteristics is set out in Appendix B.

2.4 STAGE 3

Stage 3 of the study was concerned with examining
pedestrians' preferences between different types of well
constructed footway surfacing types selected by officers of
Sheffield City Council. It was intended that the site would be
used for future research. Surfacing materials selected for
testing were:

    – A   Small element flags (chamfered)
    – B   Small element flags (pencil arris)
    – C   Convential large flags
    – D   Black top ('wardtite' wearing course)
    – E   Black top (medium graded wearing course)
    – F   Black top (slurry seal)
    – G   Block paving (pencil arris)
    – H   Block paving (chamfered)

Further details are given in Appendix D.

Several sites were examined to find one that would be suitable
and which would have the following characteristics:

–   be sufficiently busy to find enough potential
     respondents;
–   needing relaying;
–   of sufficient size to allow the eight 10m x 2m areas of
     new materials to be laid.

Initially it was hoped to find a site that could be laid out
with the areas in a rectangle, rather than in a long row,
since this would have made it easy to change the order in
which areas were exposed to the respondents. However the best

available site required the areas to be laid out in a long
line. Appendix E shows the site, which was at Barkers Pool,
Sheffield City Centre.

The questionnaire (see Appendix F) was adapted from elements
of the Stage 2 questionnaire, together with new questions
reflecting the objectives of Stage 3. This was piloted on 18
September 1989 among 21 respondents. The main interviews were
conducted during 22-29 September 1989, and occupied 12
interviewer days. The weather was fine. As in Stage 2,
pedestrians were randomly sampled within each of the four
identified Ability groups. Since the Stage 3 interviews were
lengthy, a lottery with prizes totalling £160 was arranged to
encourage participation. This proved to be a success.

A total of 186 people were interviewed. In Table 2.12 the age
and sex distributions of the interviewees are shown. Overall
68% were females and 32% male, reflecting the ratio found in
other research (May and Hopkinson, 1989). The percentage of
females in each ability category is shown in Table 2.13. As
can be seen, each group consisted of about two-thirds females
to one-third males, with the clear exception of the encumbered
category with 4 in 5 people being female.

TABLE 2.12   **STAGE 3 RESPONSES: SEX DISTRIBUTION
BY AGE**

	Sex	
Age	Female	Male
<21	58%	42%
21-30	73%	27%
31-40	68%	32%
41-50	72%	28%
51-60	70%	30%
61-70	70%	30%
>70	53%	47%
Overall	68%	32%

TABLE 2.13   **STAGE 3 RESPONSES: SEX DISTRIBUTION BY
ABILITY GROUP**

	Sex	
Ability	Female	Male
Young mobile ($\leq$ 50 years old)	65%	35%
Elderly mobile (> 50 years old)	63%	37%
Disadvantaged (disabled)	61%	39%
Disadvantaged (encumbered)	80%	20%

Starting at either end of the line of eight areas, respondents
walked over each of them in turn and were asked for their

reactions. Where respondents considered that a surface material might cause them difficulty, they were asked to indicate what it was about the surface that caused them difficulty, and this was recorded. Sometimes some help was necessary to enable respondents describe their problems. Where this occurred the fact was recorded. After respondents had walked over all the areas, they were asked to rank their preferences and to comment on the best and worst areas.

It had been noticed in the piloting of Stage 3 that many respondents said that while a particular material was satisfactory now, it would cease to be as satisfactory in the future. To accommodate those respondents who wished to express an opinion on the likely future condition of the materials, in the final version of the questionnaire respondents were asked to rank their preferences for the materials as they might be in "a couple of years", and to explain any changes in their preferences. Respondents were also asked which surfacings they would consider "most and least appropriate" in different areas of a city - e.g. an area full of historic buildings, or a modern housing estate. Finally, respondents were asked about pavement colour preferences.

3. STAGE 2 RESULTS

3.1 VARIABLES AND OBJECTIVE MEASURES USED IN THE ANALYSIS

As detailed in Section 2, users were asked to judge their satisfaction or otherwise with different types and standards of footway. To enable this to be achieved, it was necessary to determine quantifiable objective measures for the test footway areas, and to set these measures against the subjective responses obtained from the pedestrian users sampled.

The objective measures used in the Study are listed in Table 3.1, with further explanatory and analytical details being set out in Appendix B. It will be noted that in many instances a number of different measures were developed and subsequently tested. This was undertaken in order to determine which of the measures was the most appropriate one for the particular variable being investigated.

3.2 EASE OF MEASUREMENT OF VARIABLES

When assessing whether a length of footway is in need of immediate maintenance or re-construction, there is an obvious advantage in being able to quantify its existing standard easily and quickly, and to compare the obtained value with the adopted threshold standard. This is the ideal, but unfortunately it is often not achievable.

In Section 2.3, the five variables to be used in the Study were identified following the Stage 1 exercise. As was seen the five most important variables were considered to be:

a)   the amount of footway undulation or unevenness;
b)   raised edges (i.e. differences in height between adjacent pavers) which can cause tripping;
c)   the roughness of the footway - sufficient friction being necessary to prevent slipping;
d)   the degree of break-up of the footway - usually resulting from over-riding by vehicles;
e)   the width of gap between pavers, potentially trapping shoe heels, walking sticks and even pram/pushchair wheels.

Only two of these variables can be measured easily and quickly, namely the frictional qualities of the footway and the amount of footway break-up. In this Study the frictional quality of the footways was measured using the TRRL portable Skid Pendulum. This is an instrument which is normally used for measuring the skidding resistance of a road. It is

recognised that the Skid Pendulum was developed to determine
the maximum coefficient of friction between a vehicle tyre
travelling at 50km/h and a road surface, and not the friction
between the sole of a shoe and a footway. However, in the
absence of a more suitable measuring device which has been
adequately tested and calibrated, and when coupled with the
fact that most Highway Authorities have a Skid Pendulum, it
was decided to measure the frictional qualities of the
footways using this device, as in a previous TRRL sponsored
study (Berrett et al, 1989). The frictional value established
for each test area was the mean of three randomly chosen
observations.

The other variable capable of quick and easy measurement is
the amount of footway break-up. This was determined by simply
measuring the percentage of pavers that were broken or cracked
within each test area measuring 10m x 2m. It should be noted
that no attempt was made to distinguish between different
degrees of brokenness. A paver was broken or cracked, or it
was not.

The other three variables required more detailed and time
consuming measurements in order to establish appropriate
values for the objective measures (see also Section 2). The
amount of undulation necessitated measuring the heights at
each node of a rectangular grid covering each test area of 10m
x 2m, with the nodes being at 0.5m spacing. A laser level was
used. The determination of the length of raised edges or gaps
above a certain specified size necessitated very careful
measurements, particularly for those footways constructed
using block paving or small element flags where the total
length of jointing between pavers in each test area needing to
be examined was very high.

3.3 INTER-RELATIONSHIP BETWEEN VARIABLES

From a quick perusal of Table 3.1, it will be apparent that
some of the variables used in the study are inter-related.
For example, for all of the footway sufaces tested, with the
exception of black top, increased undulation will be
positively associated with increased length of raised edges
and the number of broken pavers, if not also with increased
size of gaps between pavers. This means that, although users
of the footway were asked to give a separate subjective
assessment for each of the variables tested, it is inevitable
that their assessment will be conditioned, to some extent, by
the other associated attributes of the footway. For example,
an individual's assessment of the problems caused by raised
edges for a particular surface, and hence tripping, may be
sub-consciously influenced by the visual impression created by
broken pavers.

In studies of this kind, where subjective responses are being obtained from a wide spectrum of users, it is inevitable that there will be considerable variation in the responses obtained for each variable at a particular footway test area. In addition, the inter-relationship between some of the variables will tend to further increase this response variability. This has influenced our approach to deriving acceptable threshold values for the variables included in the Study. The method adopted is set out in the following Section 3.4.

3.4 BASIS FOR DETERMINING APPROPRIATE THRESHOLD STANDARDS

In the field work carried out in the Study, and detailed in Section 2, the sampled pedestrians were presented with a statement relating to each of the five variables being used, in turn, and asked to respond on the following five point scale:

1) Strongly agree
2) Agree
3) Neither agree nor disagree
4) Disagree
5) Strongly disagree.

For example, for the variable 'raised edges', the sampled pedestrians were asked to respond to the statement "Too many of the pavers or blocks on this marked area have raised edges which can trip people up".

For each area (10m x 2m) covering a particular footway type, the mean response for each user group was calculated and plotted against the value of the objective measure being used for the particular variable, as shown in the hypothetical example in Figure 3.1 (page 20).

TABLE 3.1 VARIABLES AND OBJECTIVE MEASURES USED IN THE ANALYSIS

Variable	Objective Measures Used in the Analysis
A. Undulation*	Sea 1- standard error of estimate (regressed) (cms) Mada 1 - mean absolute deviation (regressed) (cms) Sea 2 - standard error of estimate (non-regressed) (cms) Mada 2 - mean absolute deviation (non-regressed) (cms)
B. Raised Edges* (Tilt)	Tila 1-% length of raised edges >5mm high Tila 2-% length of raised edges >10mm high Tila 3-% length of raised edges >15mm high
C. Friction	Sli 1 - Values obtained using the standard TRRL skid pendulum
D. Broken Pavers	Brok 1 - Percent of broken pavers in the standard test area 10m x 2m
E. Gaps*	Gapa 5 - % length of gaps >5mm between pavers Gapa 10 - % length of gaps >10mm between pavers Gapa 15 - % length of gaps >15mm between pavers Gapa 20 -% length of gaps >20mm between pavers

*Notes: *   These measurements relate to the standard test area adopted in the study of 10m x 2m.
           *   For definitions, see Appendix B

The values of the objective measures for each of the test areas (10m x 2m) used in the Study are set out in Table 3.2.

TABLE 3.2 MEASURED CHARACTERISTICS OF THE STUDY AREAS, EACH 10m x 2m

Site	Area	Footway Type	Undulation (cm)				Raised Edges (%)			Friction	Broken Pavers (%)	Gaps (%)			
			Sea 1	Mada 1	Sea 2	Mada 2	Tila 1	Tila 2	Tila 3	Sli 1	Brok 1	Gapa 5	Gapa 10	Gapa 15	Gapa 20
Pinstone Street	11	S	7.47	6.03	4.60	3.76	12.3	1.0	0	45	0	100	100	21.6	0
(1)	12	S	5.84	4.75	2.82	2.18	2.9	0	0	46	0	100	100	11.7	0.5
	13	S	4.30	3.63	2.33	1.76	0	0	0	40	1	100	100	1.4	0
Moor/Fitzwilliam	21	B	36.60	30.80	6.45	4.98	0.5	0.4	0.1	58	0	100	100	100	0
Gate (2)	22	B	13.00	10.50	5.63	3.98	0.1	0	0	68	0	100	100	100	0
	23	B	8.18	6.55	3.99	3.06	0	0	0	63	0	100	100	100	0
Moor (Marks and	31	B	22.30	17.80	6.07	4.57	0.9	0.1	0	62	0	100	100	100	0.9
Spencers) (3)	32	B	9.54	7.78	4.28	3.22	0.5	0	0	58	0	100	100	100	0.3
	33	B	18.80	15.10	3.72	2.82	0	0	0	67	0	100	100	100	0
Manor Top (4)	41	T	30.20	21.30	20.50	8.57	-	-	-	68	-	-	-	-	-
	42	T	7.27	5.48	6.21	4.43	-	-	-	68	-	-	-	-	-
	43	T	7.72	6.33	3.74	2.92	-	-	-	63	-	-	-	-	-
Manor Top (5)	51	F	6.18	5.04	4.31	3.29	9.2	1.9	0	70	94	30.1	14.8	2.1	0
	52	F	12.70	6.93	15.10	6.69	8.7	0	0	69	30	48.2	5.3	0.5	0
	53	F	9.10	7.33	4.40	3.13	6.0	1.6	0	71	67	1.9	1.9	1.9	0
Ecclesall (6)	61	F	9.44	7.12	3.84	3.04	24.5	10.3	3.5	56	0	37.1	8.1	0	0
	62	F	11.10	6.41	11.10	5.10	24.8	4.0	0	64	34	27.6	2.9	1.6	1.6
	63	F	14.80	9.27	8.77	4.95	20.0	3.9	1.0	63	6	13.1	3.4	1.0	0.5
Langsett Road/	71	S	8.76	5.98	9.00	4.85	15.9	1.8	0.3	54	1	100	100	5.0	2.3
Hillsborough (7)	72	S	10.20	7.18	5.18	4.01	12.6	1.2	0.2	52	0	100	100	7.2	1.8
	73	S	7.48	5.94	4.02	3.03	5.2	0	0	51	1	100	100	3.9	2.7
Moor/Fitzwilliam	81	S	-	-	-	-	-	-	-	-	-	-	-	-	-
Gate (8)	82	B	13.00	10.50	5.63	3.98	0.1	0	0	68	0	100	100	100	0
	83	F	8.15	6.70	4.22	3.55	19.0	2.4	0	64	15	18.9	7.7	0.5	0
West Street (9)	91	F	7.80	5.21	6.35	3.09	4.7	0	0	62	6	58.9	1.0	0	0
	92	S	13.50	10.10	8.19	6.17	22.3	5.1	1.0	60	3	18.5	3.7	2.2	0
	93	T	22.00	18.00	11.00	4.99	-	-	-	65	-	-	-	-	-
Darnall (11)	111	T	9.27	7.55	4.43	3.02	-	-	-	72	-	-	-	-	-
	112	T	13.80	9.88	8.52	4.50	-	-	-	63	-	-	-	-	-
	113	T	12.30	10.30	4.38	3.35	-	-	-	67	-	-	-	-	-
Chesterfield	121	T	11.00	8.36	3.96	3.15	-	-	-	69	-	-	-	-	-
Road/	122	T	15.70	10.90	16.30	8.89	-	-	-	72	-	-	-	-	-
Tesco (12)	123	T	9.55	7.24	6.99	5.30	-	-	-	68	-	-	-	-	-
Chesterfield	131	F	8.85	6.56	5.42	4.04	16.0	6.3	1.0	63	12	37.9	21.0	5.0	3.1
Road/ Fashion	132	F	19.00	5.64	23.20	7.46	11.0	0	0	64	6	9.5	2.9	1.0	0
Focus (13)	133	F	7.96	6.16	4.34	3.00	15.6	3.4	0	64	6	38.2	17.7	4.7	1.6
Fitzwilliam	151	S	9.09	7.42	4.51	3.20	10.2	1.6	0	68	0	100	100	0.9	0
Square (GPO)	152	S	10.40	4.98	14.70	4.80	2.1	0	0	68	0	100	100	0.6	0.2
(15)	153	S	3.71	2.88	2.08	1.65	0.9	0	0	65	0	100	100	0	0

Key   B = Block paving   F = Conventional large flags   S = Small element flags   T = Black top
Site numbers are shown in brackets

Figure 3.1   Method for determining threshold standards
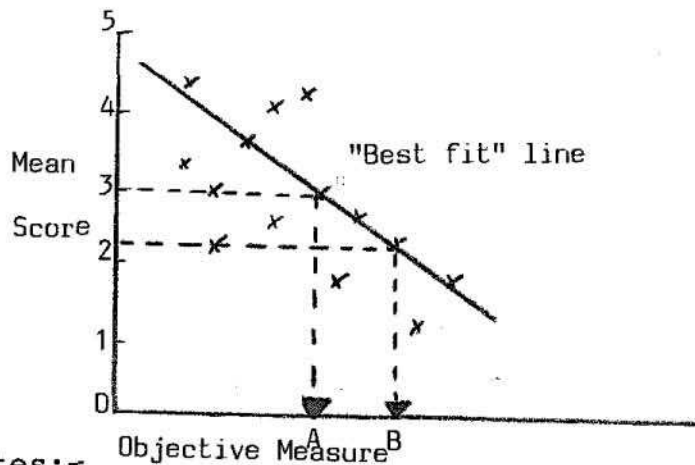
Notes:-

(1) A hypothetical example is shown to illustrate the method

(2) Value A (derived from a score of 3) represents the
     threshold used as a basis for the Study recommendations

(3) Value B (derived from a score of 2.5) is the alternative
     threshold used in Section 3.7

(4) A mean score of 5 indicates a high level of satisfaction
     with the conditions; a mean score of 3 represents a
     neutral reaction; a mean score of 1 indicates a high
     level of dissatisfaction.

Where a relationship was apparent, a 'best fit' line (not
necessarily a straight line) was drawn in by eye through the
plotted points, as shown in Figure 3.1, and the appropriate
threshold standard (point A in Figure 3.1) chosen to coincide
with the neutral subjective assessment value (=3). However,
the resulting thresholds may, in certain circumstances, prove
impractical on cost or other grounds. An alternative set of
less stringent thresholds has been produced using a lower
(less satisfied) subjective assessment value of 2.5 (point B
in Figure 3.1). The results for this are presented in Section
3.7.

3.5 RESULTS OBTAINED

The results set out in this Section were obtained using the
analysis technique described in Section 3.4. In many cases it
was not possible to derive a meaningful threshold value for a
particular variable measure due to the high variability in the
results (shown marked - in the Tables, see Appendix G), and in
a number of further cases the relationship from which the
threshold value was derived was weak (shown marked * in the

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Tables). In all other cases, the threshold standard was derived from an acceptably strong relationship between users' subjective assessment and the objective measure for the variable.

The full set of results obtained are presented, without comment, in Appendix G. For each variable, where appropriate, the results are set out in the order:

1) All users
2) Ability group
3) Sex
4) Age.

In Section 3.6 the results are critically examined, before the presentation of suggested threshold standards in Section 3.7.

3.6 CRITICAL APPRAISAL OF RESULTS

Introduction

The Section is divided into two main parts. The first is concerned with determining what objective measures can be potentially used for establishing threshold standards for footway maintenance when the nature of the collected footway data is taken into consideration; while in the second part the results, which have been obtained and which have been set out in Appendix G (Tables G.1 to G.17), are critically examined.

Possible Objective Measures for Different Footway Types

If realistic acceptable threshold standards of maintenance for different types of footway are to be established, then the values of the objective measures obtained for a particular footway type must satisfy two important conditions, namely:

1) they must embrace a sufficiently wide range in order to induce a suitably wide spectrum of user subjective response;

2) the mean should tend towards the middle of the range;

Using the basic data of Table 3.2, the arithmetic mean and range was established for each objective measure and these are set out in Table 3.3. The two criteria were then applied to these data, and yielded the variables (and objective measures) most likely to result in satisfactory threshold standards being produced. These have been tabulated in Table 3.4.

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TABLE 3.3 MEANS AND RANGES FOR THE OBJECTIVE MEASURE

Variable	Objective Measure	Block Paving		Conventional flags		Small element flags		Blacktop	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Undulation (cms)	Sea 1	17.35	8.18-36.60	10.46	6.18-19.00	8.08	3.71-13.50	13.88	7.27-30.20
	Mada 1	14.15	6.15-30.80	6.58	5.04-19.27	5.89	2.88-10.10	10.53	5.48-21.30
	Sea 2	5.11	3.72- 6.45	8.28	3.84-23.20	5.74	2.08-14.70	8.60	3.74-20.50
	Mada 2	3.80	2.82- 4.98	4.30	3.00- 7.46	3.54	1.65- 6.17	4.91	2.92- 8.89
Raised Edges (%)	Tila 1	0.3	0 - 5.3	14.5	4.7-24.8	9.4	0 -18.9	N/A	N/A
	Tila 2	0.06	0 - 0.4	3.1	0 -10.3	1.1	0 - 4.9	N/A	N/A
	Tila 3	0.02	0 - 0.1	0.5	0 - 3.5	0.2	0 - 1.0	N/A	N/A
Friction	Sli 1	63.4	58 -68	64.5	56 - 71	54.9	40 - 68	67.5	63-72
Broken Pavers (%)	Brok 1	0	0	25	0 - 94	0.6	0 - 3	N/A	N/A
Gaps (%)	Gapa 5	100	100-100	29.3	1.9-58.9	91.8	17.9-100	N/A	N/A
	Gapa 10	100	100-100	7.9	1.0-21.0	90.4	3.6-100	N/A	N/A
	Gapa 15	100	100-100	1.7	0 - 5.0	6.3	0 -24.6	N/A	N/A
	Gapa 20	0.2	0-0.9	0.6	0 - 3.1	0.9	0 - 3.2	N/A	N/A

TABLE 3.4 OBJECTIVE MEASURES CAPABLE OF YIELDING ADEQUATE THRESHOLD STANDARDS OF FOOTWAY MAINTENANCE

Variable	Objective Measure	Footway Type			
		Block paving	Conventional flags	Small element flags	Black top
Undulation	Sea 1	✓	✓	✓	✓
	Mada 1	✓	✓	✓	✓
	Sea 2	✓	✓	✓	✓
	Mada 2	✓	✓	✓	✓
Raised Edges	Tila 1	x	✓	✓	-
	Tila 2	x	✓	?	-
	Tila 3	x	x	x	-
Friction	Sli 1	✓	✓	✓	✓
Broken Pavers	Brok 1	x	✓	x	x
Gaps	Gapa 5	x	✓	x	-
	Gapa 10	x	✓	x	-
	Gapa 15	x	✓	✓	-
	Gapa 20	x	x	x	-

KEY √ satisfactory   ? questionable   x unsatisfactory   - not applicable

As will be seen from Table 3.4, the field data imposes some limitations on what can be achieved from the analysis. Although the undulation and friction measures are adequate and hence are capable of yielding appropriate standards for all footway types, the data limitations indicate that measurements of raised edges and gaps are only likely to lead to positive results for Conventional Large Flags (referred to as Conventional Flags hereafter) and Small Element Flags, while the broken paver measurements can lead to positive results for Conventional Flags only.

Critical Appraisal of Results

(a) Undulation

The results of the pedestrian users' response to undulation were set out in Appendix G (Tables G.1 to G.4). From a consideration of these tables it can be determined that the objective measures Sea 1 and Mada 1 provided stronger relationships from which threshold values could be derived than Sea 2 and Mada 2. In consequence of this, all further discussion will be centred on Sea 1 and Mada 1.

For Conventional Flags and Small Element Flags, it was found that the calculated threshold standards were similar. Furthermore, although there were some differences between the obtained threshold values by Ability Group, Sex, and Age Group, these did not appear to be significant. This can be seen in Table 3.5.

TABLE 3.5 UNDULATION THRESHOLD STANDARDS BY USER GROUP FOR CONVENTIONAL FLAGS AND SMALL ELEMENT FLAGS (cms)

User Group		Conventional Flags Sea 1	Mada 1	Small Element Flags Sea 1	Mada 1
All users		11	10	7	6
Ability	1	11	8	9	6
Group	2	10	7	10	6
	3	13*	8	–	9
	4	12	8	11	7
Sex	M	11	7	11	6
	F	17*	7	12	7
Age Group	<31	9	6	9	6
	31-60	10	6	10	6
	>60	13	7	11	7

*Based on weak relationship

While both Sea 1 and Mada 1 provide adequate thresholds, it is suggested that Sea 1 is adopted as the appropriate objective measure, since it also yielded some results for Block Paving. If this is accepted, then a threshold standard of 11 for Conventional Flags and 10 for Small Element Flags would appear to be appropriate.

It has proved more difficult to establish a satisfactory undulation standard for Block Paving. Only in one instance was it possible to derive a strong relationship for Sea 1, this yielding a standard value of 8 for Ability Group 1. Weak values of 9, 10, 12 and 16 were also obtained; thus tentatively indicating that a Sea 1 threshold standard in the range 10-11 might be appropriate.

Black top yielded a number of weak Sea 1 threshold values, ranging between 10 and 22, with a mean of 15. Although no great reliance can be placed on the results obtained, since standards based on undulation are the only possible ones for Black top (with the exception of friction), a tentative threshold value in the region of 14-15 is suggested.

In summary, the suggested threshold values are set out in Table 3.6, together with the mean values obtained at the test sites.

TABLE 3.6 RECOMMENDED THRESHOLD STANDARDS FOR UNDULATION (BASED ON OBJECTIVE MEASURE SEA 1)

Surface	Suggested threshold standard (cms)	Mean measured site value (cms)
Block paving	10-11*	17.35
Conventional flags	11	10.46
Small element flags	10	8.08
Black top	14-15*	13.88

*tentative recommendation

(b) Raised Edges

From the work summarised in Table 3.4, it was concluded that it would only be practicable, because of site measurement data limitations in the range of values obtained, to determine threshold standards based on raised edges for Conventional Flags and Small Element Flags.

The results set out in Appendix G (Tables G.5 to G.8) and in Table 3.4, showed conclusively that any attempt to base a

threshold standard on the objective measure Tila 3 (percentage length of raised edges (cms) >15mm high) would be inappropriate. However, standards based on the objective measures Tila 1 and Tila 2 (raised edges >5mm and >10mm respectively) were possible.

The results obtained show some variation by Ability group and age. However it is doubtful whether these differences can be considered to be significant without further, and more extensive, study. The mean threshold values obtained for all users were:

```
Conventional flags    Tila 1 =. 12.3%    (Range 11.3% - 13.7%)
                      Tila 2 =   2.2%    (Range  1.2% -  2.6%)
Small element flags   Tila 1 =   8.7%    (Range  6.0% -11.9%)
                      Tila 2 =   1.0%    (Range  0.3% -  1.8%)
```

It should be stressed that the mean value obtained for Small Element Flags (Tila 1) was derived from results containing a total of 9 strong relationships; whereas the Tila 2 values for Large Conventional Flags and Small Element Flags and the Tila 1 value for Large Flags were derived from mainly weak relationships. Thus the Tila 1 value should be the more dependable.

Considering the evidence, it would appear satisfactory to base the objective measure for Raised Edges on Tila 1 (i.e. the percentage length of raised edges >5mm high), and with standards being adopted for both Conventional Flags and Small Element Flags, of 12% and 9% respectively. However, threshold standards based on Tila 2 (the percentage length of raised edges >10mm high) of 2% and 1% respectively for Conventional Flags and Small Element Flags could be used if this was considered more appropriate because of the greater ease of measuring the larger sized raised edge.

(c) Friction

The results obtained for the different surfaces are set out in Appendix G (Tables G.9 to G.12). Since there is little variation in the results obtained, it is recommended that a single Skid Pendulum friction threshold value of 65 should be adopted, covering all surface types.

(d) Broken Pavers

The results are shown in Appendix G (Table G.13). As can be seen only one threshold standard was obtained, for Conventional Flags. It is recommended that for this type of footway, the percentage of broken pavers should not exceed 10%.

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Although it was not possible to obtain a threshold standard for Block Pavers and Small Element Flags, since all the available sites in the city were in good condition at the time of the survey, it may be considered appropriate to adopt a similar standard of 10%

(e) Gaps

The results are set out in Appendix G (Tables G.14 to G.17) and Table 3.4.

It is to be expected that the width of gaps between pavers, and the length of such gaps, will be an important factor in determining footway quality, particularly among women with their more delicate footwear and high heels.

From an examination of the results it can be seen that it was not possible to obtain any threshold standard based on gaps for Block Pavers. Furthermore, attempts to determine standards based on Gapa 20 (percentage length of gap >20mm wide) also proved unproductive, for all footway surfaces. In addition, all threshold values based on Gapa 5 (percentage length of gap >5cms wide) were founded on weak relationships. Thus, threshold standards, based on gaps, would appear to be most readily obtainable from objective measures Tila 10 and Tila 15 (percentage length of gaps >10mm and >15mm respectively).

Examination of Table G.16 suggests that there are significant differences between acceptable standards for male and female. Thus, for this criterion, it appears necessary to distinguish between the two groups. It was also easier to determine appropriate threshold values for Large Flags rather than Small Element Flags.

Taking all the evidence into account, the recommended threshold standards are those which are set out in Table 3.7.

TABLE 3.7 RECOMMENDED THRESHOLD STANDARDS FOR GAPS (%)

Surface	Sex	Tila 10	Tila 15
Conventional flags	M	4.0%	0.8%
	F	0.8%	0.2%
Small element flags	M	–	0.2%
	F	–	0.2%

3.7 RECOMMENDED THRESHOLD STANDARDS

In this final Section, the recommended threshold standards for footway maintenance (based on the neutral subjective assessment value of 3 as set out in Section 3.4) and discussed in Section 3.6 have been brought together and summarised in Table 3.8. It will be for the practising engineer to decide whether to use these standards and whether the costs associated with them can be justified. Where costs or other considerations indicate the need for less stringent standards, those in Table 3.9, which are based on a subjective assessment value of 2.5, can be applied instead.

TABLE 3.8   RECOMMENDED THRESHOLD STANDARDS, BY FOOTWAY TYPE, BASED ON SUBJECTIVE RESPONSE VALUE 3 (SEE SECTION 3.4)

Surface	Sex	Undulation	Raised edges		Friction (Skid Pendulum value)	Broken pavers (%)	Gaps	
			>5mm	>10mm			>10mm	> 15mm
Block paving	M/F	≯10-11*	x	x	≮65	≯10	x	x
Conventional flags	M	≯11*	≯12.0%	≯2.0%	≮65	≯10	≯4.0%	≯1%
	F	≯11*	≯12.0%	≯2.0%	≮65	≯10	≯1.0%	+
Small element flags	M	≯10*	≯9.0%	≯1.0%	≮65	≯10	x	+
	F	≯10*	≯9.0%	≯1.0%	≮65	≯10	x	+
Black top	M/F	≯14-15	N/A	N/A	≮65	N/A	N/A	N/A

Note   All measurements relate to a test area 10m x 2m

Key   *   tentative recommendation
           +   gaps should be avoided completely
           x   no standard obtained
           N/A not applicable
           M/F Male/Female

TABLE 3.9:   RECOMMENDED THRESHOLD STANDARDS, BY FOOTWAY TYPE, BASED ON SUBJECTIVE RESPONSE VALUE 2.5
(SEE SECTION 3.4)

Surface	Sex	Undulation (cms)	Raised edges		Friction (Skid Pendulum value)	Broken pavers (%)	Gaps	
			>5mm	>10mm			>10mm	>15mm
Block paving	M/F	≥24*	x	x	≤60	≥15	x	
Conventional flags	M	≥21	≥17%	≥4%	≤60	≥15	≥10%	≥3%
	F	≥21	≥17%	≥4%	≤60	≥15	≥6%	≥2%
Small element flags	M	≥21	≥15%	≥2%	≤60	≥15	x	≥6%
	F	≥21	≥15%	≥2%	≤60	≥15	x	≥3%
Black top	M/F	≥19*	N/A	N/A	≤60	N/A	N/A	N/A

Note

All measurements relate to a test area 10m x 2m

Key

* tentative recommendation
x no standard obtained
N/A not applicable
M/F Male/Female

4 ASSESSMENT OF NEWLY CONSTRUCTED SURFACES

4.1 Overall Difficulty with the Area

A measure of the interviewees' overall difficulty with a
surface was achieved by asking them to agree or disagree with
the statement "I think that the marked area is difficult to
walk on". In order to avoid bias due to the leading nature of
the statement, about half the interviewees were given a
"mirror image" opposite statement instead. Results from the
Stage 2 questionnaires suggested that this technique virtually
eliminated bias in the response.

Table 4.1 presents the overall results. It can be seen that
the majority of respondents expressed either agreement or
disagreement; few expressed themselves strongly, and only the
occasional respondent was able to express a view. Overall,
there was little difference between surfaces, with between 56%
and 66% finding the area difficult to walk upon. While Surface
E (type 2 black top) was considered to be the most
satisfactory. This overall result, with a majority expressing
difficulty, is surprising given the standard of the
surfacings.

Further analysis (Appendix H) indicated that there was little
difference in response between sexes, or by ability group.
Surface F (type 3 blacktop) attracted a higher level of
criticism from women that men. Conversely surface C
(conventional flags) was considered less difficult by young
mobile respondents.

4.2 SPECIFIC DIFFICULTIES WITH EACH AREA

In order to identify more specific difficulties (such as
slipperiness or bumpiness of the surface), interviewees were
asked "what is it about the surface that you think could be
difficult?" The response was coded according to the
categories:

GAPS   Gaps between the pavers/blocks
TILT   Raised edges
SLIP   Slipperiness of surface
BUMP   Unevenness of surface.

Where respondents were unable to explain the nature of the
problem with a surface, a prompt was given to elicit a
response. In practice very few respondents had to be prompted
for details of specific problems.

TABLE 4.1 PERCENTAGE OF THOSE INTERVIEWED FINDING AREA DIFFICULT TO WALK UPON

Difficulty

Area	SA	A	TA	NA	D	SD
A	4	56	60	1	39	0
B	7	53	60	0	41	1
C	2	61	63	1	35	0
D	2	58	60	0	38	2
E	6	50	56	0	38	6
F	2	61	63	1	34	2
G	9	52	61	0	38	1
H	9	57	66	1	31	2

SA   —   strongly agree that site is difficult
A   —   agree
TA   —   total agreeing (=SA+A)
NA   —   neither agree nor disagree
D   —   disagree
SD   —   strongly disagree

Surfaces:

A   —   Small element flags (chamfered)
B   —   Small element flags (pencil arris)
C   —   Conventional large flags
D   —   Black top ("Wardtite" wearing course)
E   —   Black top (medium graded wearing course)
F   —   Black top (slurry seal)
G   —   Block paving (pencil arris)
H   —   Block paving (chamfered)

Table 4.2 shows the results, for each of the four Ability groups and overall. The following points are apparent:

1) Across all ability groups, surface H (chamfered block paving) caused most difficulty. Gaps between the blocks proved problematic for all ability groups, with 36% of those in Ability group 4 (prams, pushchairs etc.) expressing difficulty. These results support those for overall difficulty shown in Appendix H;

2) Gaps were also the main source of problem in Area A (small element flags, chamfered); by contrast raised edges were the greatest problem with Areas B (small element flags, pencil arris) and C (conventional large flags). Area G (block paving, pencil arris) performed best among the block paving sites with few expressing any problems;

3) Areas D, E and F (types of black top) clearly held few specific problems for respondents of any Ability group, although some concern with the unevenness of Area F was expressed by those in groups 2, 3 and 4 (i.e. other than the young mobile);

4) 29% of those in Ability group 3 (disadvantaged, disabled people) had difficulty with raised edges on Area C (conventional large flags), and this also appears to be their main difficulty in areas A and B (small element flags);

5) Overall fewer respondents in Ability group 3 (disadvantaged, disabled people) expressed specific problems in any area compared with respondents in other Ability categories;

6) Fewer specific difficulties are apparent for Area E (type 2 black top) than for any other area. This result supports those shown in Table 4.1, although it is unclear why this black top surface was more favoured than areas D or F.

Few respondents provided other comments, and all were concerned with the Black top sites. Table 4.3 summarises the numbers of responses received. It can be seen that the main concern was with heels becoming stuck.

TABLE 4.2: PERCENTAGE OF THOSE IN EACH ABILITY GROUP HAVING SPECIFIED DIFFICULTIES WITH EACH AREA

Ability Group		1	2	3	4	All		1	2	3	4	All
Difficulty	Area						Area					
Gaps	A	2	16	-	14	9	E	-	-	-	-	-
Raised Edges	A	6	4	11	-	4	E	-	-	-	-	-
Slipperiness	A	2	2	-	-	1	E	6	6	-	2	4
Unevenness	A	2	2	-	2	2	E	-	2	-	-	1
Gaps	B	-	-	4	-	1	F	-	-	-	-	-
Raised Edges	B	4	5	18	6	7	F	-	2	-	-	1
Slipperiness	B	2	2	-	-	1	F	8	9	-	4	6
Unevenness	B	6	4	-	4	4	F	10	18	-	12	11
Gaps	C	2	2	-	2	2	G	6	2	7	4	5
Raised Edges	C	8	18	29	6	13	G	8	6	-	6	5
Slipperiness	C	2	2	-	-	2	G	-	2	4	-	2
Unevenness	C	2	-	4	8	3	G	8	6	4	8	6
Gaps	D	-	2	-	-	1	H	20	23	18	36	25
Raised Edges	D	2	-	-	-	1	H	6	8	4	6	6
Slipperiness	D	4	6	-	4	4	H	-	4	4	-	2
Unevenness	D	8	4	-	2	4	H	4	8	4	16	8

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TABLE 4.3   ADDITIONAL COMMENTS FROM OVERALL DIFFICULTY SECTION (NUMBER OF RESPONSES)

Comment	Area D	E	F
Sticky in Summer	3	1	2
Heels sink in/get stuck	9	5	7
Bitty	-	1	-

4.3   PREFERENCES BETWEEN SURFACES AT TIME OF SURVEY

Interviewees were asked to rank each area in order of preference for walking upon from 1 (liked least) to 8 (liked most).   Joint ranking was allowed where a person had no clear preference.   The resulting rankings and mean ranking are summarised in Table 4.4, which highlights some clear preferences between surfaces.

Overall, area H (block paving, chamfered) achieved the lowest score, with areas C (conventional large flags) and F (type 3 black top) also performing badly.   The most popular areas were E (type 2 black top), B (small element flags, pencil arris) and G (block paving, pencil arris).   These results largely mirror those of Table 4.1.

TABLE 4.4 PERCENTAGE OF THOSE INTERVIEWED ASSIGNING STATED RANKS TO EACH AREA FOR CURRENT CONDITIONS

Area	RANK Worst 1	2	3	4	5	Best 6	7	8	Mean Rank Score
A	7	15	15	13	16	9	21	5	4.5
B	0	9	9	11	16	15	18	23	5.6
C	23	2	24	21	10	11	5	5	3.7
D	17	14	19	14	7	13	19	5	4.4
E	13	6	15	10	8	14	5	29	4.9
F	21	13	19	9	5	26	5	3	3.8
G	11	17	10	10	13	10	13	17	4.6
H	32	17	5	13	15	4	11	3	3.3

Comparison of mean rankings by type of respondent (Table 4.5) indicates few significant differences. Women ranked areas D and E (types 1 and 2 black top) higher than men, and areas A and H (small element flags, chamfered; and block paving, chamfered) lower. Disabled people ranked areas D and F (types 1 and 3 black top) higher than other groups, and areas G and H (block paving) lower. The elderly produced the opposite effect in their rankings, while the young mobile and the encumbered produced mean rankings similar to those for the population as a whole.

TABLE 4.5   MEAN RANK ASSIGNED TO EACH AREA (PRESENT RATING) BY TYPE OF RESPONDENT

AREA	SEX		ABILITY GROUP				TOTAL
	M	F	1	2	3	4	
A	4.9	4.3	4.7	4.7	4.4	3.9	4.5
B	5.5	5.7	6.0	5.8	5.3	5.3	5.6
C	3.6	3.7	3.8	3.7	3.1	3.9	3.7
D	3.8	4.3	3.8	3.2	5.6	4.7	4.4
E	4.6	5.2	5.2	4.1	5.4	5.6	4.9
F	3.7	3.9	3.7	2.7	5.2	4.3	3.8
G	3.7	4.6	4.5	6.0	3.0	4.4	4.6
H	3.7	3.2	3.1	4.6	2.5	2.7	3.3

Note: 1 = liked least;   8 = liked best

Areas: See Table 4.1

Ability Groups:

1 Young mobile
2 Elderly mobile
3 Disadvantaged (disabled)
4 Disadvantaged (encumbered)

Respondents were also invited to indicate why they ranked particular sites highest or lowest. The results given in Appendix H, indicate that very few volunteered specific reasons for their preferences.

4.4   ANTICIPATED FUTURE PREFERENCES

Having ranked each area according to their current preference, interviewees were asked to give a second ranking according to how they felt their preference may have changed in a two years time. This second series of ranks was intended to reflect how

respondents felt that the surfaces might change over time.

Overall 72% of those interviewed thought that their
preferences in surface type would not change over the next two
years. The "future" rank assigned to each area is shown in
Table 4.6 and this may be compared with the "present" rank
given in Table 4.4. Although there are broadly similar
patterns apparent in both present and future ranks, a clear
difference is seen for Area C (conventional large flags).
Respondents anticipate that this area will deteriorate within
the next two years and 34% ranked the area worst or second
worst for the future. Some change is expected for other
surface types, although chamfered block paving is ranked more
favourably for the future than at present. None of the
differences in rankings were statistically significant.

**TABLE 4.6   PERCENTAGE OF THOSE INTERVIEWED ASSIGNING RANKS
TO EACH AREA FOR CONDITIONS ANTICIPATED IN TWO
YEARS TIME**

Area	Worst			Rank				Best	Mean Rank Score
	1	2	3	4	5	6	7	8	
A	5	14	13	14	17	10	21	6	4.6
B	0	10	10	11	14	16	19	26	6.0
C	32	2	17	21	9	12	4	4	3.4
D	18	15	13	15	8	10	15	5	3.8
E	13	9	14	12	6	14	6	30	5.1
F	19	16	21	10	5	23	4	2	3.6
G	9	14	8	9	15	10	14	34	5.9
H	23	18	4	14	13	5	18	6	3.9

4.5   AESTHETIC QUALITIES

Interviewees were asked which surface types they would rank
highest, second highest, lowest and second lowest, in terms of
appearance, in each of five settings. In practice respondents did
not distinguish between areas D, E and F, and these have therefore
been grouped (as T) in the results. Table 4.7 indicates the areas
which the largest percentage ranked in each position for each
setting.

TABLE 4.7 PREFERENCES FOR PAVEMENTS TYPES IN EACH SETTING

Setting | Area ranked as indicated by the largest percentage (%)

Setting	8	7	2	1
Historic Building	G(46)	H(42)	T(63)	T(61)
Modern Shopping	B(35)	A(31)	T(58)	T(55)
Modern Housing	B(26)	H(22)	T(38)	T(38)
Victoria Housing	G(41)	H(36)	T(62)	T(61)
Village Street	G(26)	H(25)	T(58)	T(56)

Key: Ranking: 8 best, 1 worst
   A,B,G,H: see Table 4.1, T = all black top
   ( ):   percentage giving that ranking

Black top (areas T) was disliked universally, with the greatest
frequency of interviewees expressing a dislike for that surface in
all categories of surroundings. The result is in contrast to the
results from other sections which showed interviewees to have few
specific difficulties in using Black top surfaces.

Slightly more variation was found in the surfaces liked most
although G (block paving, pencil arris) and H (block paving,
chamfered) were consistently favoured. Exceptions were for modern
shopping areas and modern housing areas where A (small element
flags, chamfered) and B (small element flags, pencil arris) were
liked.

The final question concerned preferred colours. Respondents were
offered four colours, but with no prompt as to surroundings. The
results are summarised in Table 4.8.

Definite preferences emerged between different colours, with black
being disliked most. 55% of respondents expressed a dislike for
black as a footpath colour. Sand was most strongly favoured, with
81% of interviewees liking the colour, and brick red was generally
liked as a second preference. 18% of interviewees felt that their
colour likes and dislikes depended chiefly on the surroundings.

TABLE 4.8   PERCENTAGES EXPRESSING DIFFERENT PREFERENCES AS TO COLOUR

COLOUR	LIKE	DISLIKE	NO PREFERENCE
BLACK	15	59	26
BRICK RED	67	16	17
GREY	51	17	32
SAND	88	3	9

Note: 18% who considered that the choice of colour depended on
surroundings have not been included.

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5. SUMMARY AND CONCLUSIONS

5.1 OBJECTIVES

The objectives of this study were:-

1) to obtain pedestrians' reactions to the quality and acceptability of footways of different construction in different conditions;
2) to assess pedestrians' preferences for different types of footway construction;
3) to assess at what stage the footway becomes unacceptable to the user, and hence requires maintenance or reconstruction.

5.2 STUDY METHOD

The study involved three stages:-

1) identification of the characteristics of concern to pedestrians;
2) determination of attitudes to different (measured) values of each of these characteristics;
3) determination of attitudes to well-constructed footways of different types.

5.3   CHARACTERISTICS OF CONCERN TO PEDESTRIANS

When respondents were asked, unprompted in Stage 1, to identify positive aspects of streets, only a minority mentioned footway condition; the most commonly mentioned aspect was absence of traffic. However, when asked to identify negative aspects, the majority of comments concerned the state of footways. This is clearly, therefore, a serious cause of concern.

The problems most frequently referred to were:

- overall difficulty or danger (representing concern for the totality of problems which may be encountered, rather than particular characteristics of surfacings);
- elements that were broken or cracked;
- gaps between adjacent elements;
- general unevenness of the surface;
- quality of repairs;
- raised or tilted elements, resulting in upstands;
- slipperiness of elements.

While general conclusions cannot be drawn from the results of the questions seeking comments on specific areas in Stage 1, they indicated clearly that pedestrians were able to distinguish between different types of surface and their conditions.

5.4 THRESHOLDS FOR FOOTWAY MAINTENANCE

Stage 2 provided data which enabled mean assessment scores for each type of respondent (both sexes, four Ability groups, and three age

groups) to be related to objective measurements of footway
condition. A threshold for maintenance action was specified as that
level at which, on average, respondents neither agreed or disagreed
with the statement posed on footway quality.

Generally, there were few significant differences between Ability
groups for the thresholds identified. The one significant
difference between the sexes was for gaps, where females were less
tolerant, presumably because of problems with heels. In this case
the threshold for females has been recommended.

Inevitably, some of the thresholds identified are less certain than
others, either because of scatter in respondents' answers, or
because the sites studied did not present a full range of
conditions. With these qualifications, the recommended thresholds
are set out in Table 5.1.

Where cost or other circumstances make it difficult to achieve
conditions better than these thresholds, an alternative, less
stringent, set of thresholds has been developed, as set out in Table
5.2.

5.5 ASSESSMENT OF NEWLY CONSTRUCTED SURFACES

Stage 3 obtained users' reactions to the following eight types of
surfacings, which had been laid specifically for the study:-

A - Small element flags (chamfered)
B - Small element flags (pencil arris)
C - Conventional large flags
D - Black top ("Wardtite" wearing course)
E - Black top (medium graded wearing course)
F - Black top (slurry seal)
G - Block paving (pencil arris)
H - Block paving (chamfered)

The surface which was considered easiest to use was the small
element flag with a pencil arris. Block paving with a pencil arris
also performed well, as did some types of black top. By contrast,
conventional large flags were considered less satisfactory, and
chamfered elemental surfaces particularly so. The most commonly
cited problems were gaps with chamfered elements and raised edges
with other elemental surfaces. Females were more likely to be
critical of black top than were males; the main concerns were with
heels sinking in and the surface becoming sticky when hot.

When asked how the surfacings would perform in two years time,
similar preferences emerged. However, it appeared that conventional
large flags were expected to deteriorate more rapidly.

When asked about the aesthetic qualities of the surfacings,
respondents indicated a strong preference for elemental surfaces
over black top. Block paving was generally favoured, with some
preference for small element flags in modern settings. Sand was the
preferred colour, followed by brick red. Black was the most
disliked colour.

TABLE 5.1: RECOMMENDED THRESHOLD STANDARDS, BY FOOTWAY TYPE, BASED ON SUBJECTIVE RESPONSE VALUE 3 (SEE SECTION 3.4)

Surface	Sex	Undulation	Raised edges		Friction (Skid Pendulum value)	Broken pavers (%)	Gaps	
			>5mm	>10mm			>10mm	> 15mm
Block paving	M/F	≥10-11*	x	x	≤65	≥10	x	x
Conventional flags	M	≥11*	≥12.0%	≥2.0%	≤65	≥10	≥4.0%	≥1%
	F	≥11*	≥12.0%	≥2.0%	≤65	≥10	≥1.0%	+
Small element flags	M	≥10*	≥9.0%	≥1.0%	≤65	≥10	x	+
	F	≥10*	≥9.0%	≥1.0%	≤65	≥10	x	+
Black top	M/F	≥14-15	N/A	N/A	≤65	N/A	N/A	N/A

Note   All measurements relate to a test area 10m x 2m

Key
* tentative recommendation
+ gaps should be avoided completely
x no standard obtained
N/A not applicable
M/F Male/Female

TABLE 5.2: RECOMMENDED THRESHOLD STANDARDS, BY FOOTWAY TYPE, BASED ON SUBJECTIVE RESPONSE VALUE 2.5 (SEE SECTION 3.4)

Surface	Sex	Undulation (cms)	Raised edges		Friction (Skid Pendulum value)	Broken pavers (%)	Gaps	
			>5mm	>10mm			>10mm	>15mm
Block paving	M/F	≯24*	x	x	≮60	≯15	x	
Conventional flags	M	≯21	≯17%	≯4%	≮60	≯15	≯10%	≯3%
	F	≯21	≯17%	≯4%	≮60	≯15	≯ 6%	≯2%
Small element flags	M	≯21	≯15%	≯2%	≮60	≯15	x	≯6%
	F	≯21	≯15%	≯2%	<60	≯15	x	≯3%
Black top	M/F	≯19*	N/A	N/A	≮60	N/A	N/A	N/A

<u>Note</u>

All measurements relate to a test area 10m x 2m

<u>Key</u>

* tentative recommendation
x no standard obtained
N/A not applicable
M/F Male/Female

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REFERENCES

Berrett B, Leake G R, May A D, Parry T and Whelan J (1988)
Ergonomic Standards for Pedestrian Areas for Disabled People:
Results from observation work.   WP 255 ITS Leeds.

Berrett B, Leake G R, May A D and Parry T   (1989)   Ergonomic
standards for pedestrian areas for disabled people: Results from
Leeds observation work 1988/9   WP 275 ITS Leeds.

Leake, G R and May A D (1989)   Determination of priorities for
footway reconstruction: research design.   TN 248 ITS Leeds.

APPENDIX A

Stage 1 and Stage 2 (two versions)

Interview Forms

Sheffield STAGE 1 SURVEY FORM (specified areas) DRAFT 6

Introductory preamble:

Excuse me, we are doing some research on behalf of the City Council and we would like to seek your views for a couple of minutes about shopping areas in Sheffield.

[Give assurances as appropriate on confidentiality (no name requested); and brevity of interview.]

[Use "footpath", "pavement" or whatever term the respondent uses]

First, You may think that there are features of this or other streets that tend to help or hinder you as you walk about. I'd like to ask you to list any features of streets that you think tend to help or hinder your progress. [Do not prompt with examples].

[ ][ ]

[Note helping features:]

[ ][ ]

[Note hindering features:]

[ ][ ]

[ ][ ]

Now I'd like to ask you about the footpath you have just been walking along. How would you describe it?

[Note location and material. Look for overall judgement; write down key-words used, eg "OK", "good", "poor", etc..]

[ ][ ]

I'd like you to look about the immediate area we are in and find the area of footpath that you consider to be the best just around here.

[note identification of area]

[ ][ ]

I'd like you to look about the immediate area we are in and find the area of footpath that you consider to be the worst just around here.

[note identification of area]

[ ][ ]

[Go to better area]
In what ways is this the best area?

[Note terms/concepts used.]

[ ][ ]

[ ][ ]

A.1

[Probe for meaning of the terms used. Help the respondent by
probing questions such as:
        What do you mean when you say .... (the phrase
        used by the respondent)?;
        In what way?   Why?
        Show me what you mean in this area.
Note key-words used]

[ ][ ]

[ ][ ]

[ ][ ]

[Ring material in area:
Large concrete flags   Small flags
Small flags   Brick
York stone   Tarmac
Other (Please describe)]

[ ][ ]

[Go to worse area]
In what ways is this the worst area?

[ ][ ]

[ ][ ]

[Probe for meaning of the terms used. Help the respondent by
probing questions such as:
        What do you mean when you say .... (the phrase
        used by the respondent)?;
        In what way?   Why?
        Show me what you mean in this area.
Note key-words used]

[ ][ ]

[ ][ ]

[ ][ ]

[Ring material in area:
Large concrete flags   Small flags
Small flags   Brick
York stone   Tarmac
Other (Please describe)]

[ ][ ]

[Go to original area of contact with respondent, or select third
area]
Can you point out features of this footpath that you think are
good or bad?

[ ][ ]

[ ][ ]

[Note features and particularly the terms used by respondents]

Category of respondent: [please ring]

M   F   less than 21
                                            21 - 30
Able bodied   31 - 40   [ ] M: 1
Disadvantaged (stick etc)   41 - 50   F: 2
Disadvantaged (prams, luggage, children)   51 - 60   [ ] AB: 1
                                            61 - 70   D S: 2
                                            70+   D P: 3

                                                              [ ] AGE
                                                                  1 - 6

stage1b   tp/tp discC

A.2

SHEFFIELD STAGE2 SURVEY FORM   DRAFT 6 VERSION 1   10/7/89

1 [Record Date:]   DAT [I]

2 [Record Site:]   SIT [ ][ ]

3 [Record Interviewer's name:]   INT [ ][ ]

Excuse me, we are doing some research on behalf of the City
Council and we would like to seek your views for a couple of
minutes about footpaths in Sheffield.
[Give assurances as appropriate on confidentiality and brevity
of interview]

4 Sex: M   F   SEx [ ]

5 Age: <21   21-30   31-40   41-50   51-60   61-70   71+   AGE [ ]

Able Bodied greater than, or equal to 51 1
Able Bodied less than 51 2   CAT [ ]
Disadvantaged (stick, wheelchairs, other aids to walking) 3
6 Disadvantaged (prams, pushchairs, luggage, children)] . . 4

[**Explain that you want the respondent to look at the marked
areas. Go to first appropriate area and point out the marked
area to respondent. Use "footpath", "pavement" or whatever term
the respondent uses.**]

I'm going to read out a number of things that people sometimes
say about footpaths, and then I'm going to ask you how strongly
you agree or disagree with the statements about the marked areas.
You can say that you strongly agree with the statement, that you
agree with the statement, that you neither agree or disagree with
the statement, that you disagree with the statement, or that you
strongly disagree with the statement. Feel free to disagree or
agree with any of the statements. This card will help you see
what choices of answer you have.

[Give respondent show card. Ensure respondent knows what is
expected of him or her. **Stress that the statements apply only
to the marked areas**]

7 [**Note identity of marked area**]   A   B   C   [ ]

The first statement is this:
I think that the marked area is not difficult or dangerous to/
walk on [or if a pushchair etc used] wheel a pushchair on.

How strongly do you agree or disagree with that statement?
8 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

Thank you. Now I'm going to read out some more statements and
ask you how much you agree or disagree with them.   These
questions are about the detail of the marked area so I would
like you to have a good look at the area before you make up your
mind.

A.3

The first of these statements is about/ whether too many of the pavers/bricks are broken [or in the case of tarmac] whether the tarmac is too broken up. Here is the statement:

I think that/ too many of the pavers/bricks are broken up [or in the case of tarmac] too much of the tarmac in the area is cracked and broken.

9 How strongly do you agree or disagree with that statement? [   ]
   Choose from: SA   A   NAD   D   SD   [DK]

[Omit for tarmac] The next statement is about whether the gaps between the pavers/bricks are too wide so that your stick/wheels/heel could get stuck in them or trip up over them.

[Omit for tarmac. Ensure that respondent understands that you are not talking about individual broken pavers, but the gaps between pavers]

[Omit for tarmac] Here is the statement: I think that there are too many gaps between pavers/bricks that I could catch my stick/wheels/heel in or trip up on in this marked area.

[Omit for tarmac] How strongly do you agree or disagree with that statement?   Choose from:
10 SA   A   NAD   D   SD   [DK]   [   ]

The next statement is about how even or regular the surface is, that is whether it undulates or tends to bump up and down.

Here is the statement: I think that this marked area is regular, and doesn't tend to be uneven.

11 How strongly do you agree or disagree with that statement? [   ]
   Choose from: SA   A   NAD   D   SD   [DK]

The next statement is to do with how well any repairs in the marked area have been conducted, that is, whether you think any mending of the footpath in the marked are has been done well enough.

Here is the statement: All the repairs, if any, in the marked area are adequate to walk on.

   How strongly do you agree or disagree with that statement?
   Choose from: SA   A   NAD   D   SD   [DK]   [   ]
12 [If "no repairs" then SA]

The next statement on this marked area is to do with/ pavers or bricks [or if tarmac:] surfaces/ that are raised or tilted so that the edges stick up and people trip over them.

Here is the statement. Too /many of the pavers or bricks [or if tarmac:] much of the surface/ on this marked area have/has raised edges which can trip people up.

   How strongly do you agree or disagree with that statement? [   ]
13 Choose from: SA   A   NAD   D   SD   [DK]

The last statement on this marked area is to do with how slippery or easy to grip you find this surface.

Here is the statement. I find that the material in the marked area gives good grip, so I don't slip even when it's wet.

14 How strongly do you agree or disagree with that statement?
Choose from: SA   A   NAD   D   SD   [DK]   [   ]

Thanks. Now I'd like us to go to the next marked area.

[Go to marked area and Note identity of marked area]

15   A   B   C   [   ]

I will make the same statements here as I did before. If you are not clear what the statement means, please say so. Please have a good look at the marked area before answering.

I think that the marked area is not difficult or dangerous to/ walk on [or if a pushchair etc used] wheel a pushchair on.

16 Choose from: SA   A   NAD   D   SD   [DK]   [   ]

I think that/ too many of the pavers/bricks are broken up [or in the case of tarmac] too much of the tarmac in the area is cracked and broken.

17 Choose from: SA   A   NAD   D   SD   [DK]   [   ]

[Omit for tarmac] I think that there are too many gaps between pavers/bricks that I could catch my stick/wheels/heel in or trip up on in this marked area.

18 Choose from: SA   A   NAD   D   SD   [DK]   [   ]

I think that this marked area is regular, and doesn't tend to be uneven.

19 Choose from: SA   A   NAD   D   SD   [DK]   [   ]

All the repairs, if any, in the marked area are adequate to walk on.
[If "no repairs" then SA]

20 Choose from: SA   A   NAD   D   SD   [DK]   [   ]

Too /many of the pavers or bricks [or if tarmac:] much of the surface/ on this marked area have/has raised edges which can trip people up.

21 Choose from: SA   A   NAD   D   SD   [DK]   [   ]

I find that the material in the marked area gives good grip, so I don't slip even when it's wet.

22 Choose from: SA   A   NAD   D   SD   [DK]   [   ]

A.5

Thanks. Now I'd like us to go to the last marked area.
[Go to marked area]

23 [Note identity of marked area]   A   B   C   [ ]

I will make the same statements here as I did before. If you
are not clear what the statement means, please say so. Please
have a good look at the marked area before answering.

I think that the marked area is not difficult or dangerous/ to
walk on [or, if a pushchair etc used] wheel a pushchair on.

24 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I think that/ too many of the pavers/bricks are broken up [or
in the case of tarmac] too much of the tarmac in the area is
cracked and broken.

25 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

[Omit for tarmac] I think that there are too many gaps between
pavers/bricks that I could catch my stick/wheels/heel in or trip
up on in this marked area.

26 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I think that this marked area is regular, and doesn't tend to
be uneven.

27 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

All the repairs, if any, in the marked area are adequate to walk
on.   [If "no repairs" then SA]

28 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

Too /many of the pavers or bricks [or if tarmac:] much of the
surface/ on this marked area have/has raised edges which can trip
people up.

29 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I find that the material in the marked area gives good grip, so
I don't slip even when it's wet.

30 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

Thanks very much for your cooperation.

SHEFFIELD STAGE2   SURVEY FORM   DRAFT 6   VERSION 2   10/7/89

1 [Record Date:]   DAT [ ][ ]

2 [Record Site:]   SIT [ ][ ]

3 [Record Interviewer's name:]   INT [ ][ ]

Excuse me, we are doing some research on behalf of the City
Council and we would like to seek your views for a couple of
minutes about footpaths in Sheffield.
[Give assurances as appropriate on confidentiality and brevity
of interview]

4 Sex: M   F   SEX [ ]

5 Age: <21   21-30   31-40   41-50   51-60   61-70   71+ AGE [ ]

Able Bodied greater than or equal to 51 1
Able Bodied less than 51. 2
Disadvantaged (stick, wheelchairs, other aids to walking) 3   CAT [ ]
6 Disadvantaged (prams, pushchairs, luggage, children) . . 4

[**Explain that you want the respondent to look at the marked
areas. Go to first appropriate area and point out the marked
area to respondent. Use "footpath", "pavement" or whatever term
the respondent uses.**]

I'm going to read out a number of things that people sometimes
say about footpaths, and then I'm going to ask you how strongly
you agree or disagree with the statements about the marked areas.
You can say that you strongly agree with the statement, that you
agree with the statement, that you neither agree or disagree with
the statement, that you disagree with the statement, or that you
strongly disagree with the statement. Feel free to disagree or
agree with any of the statements. This card will help you see
what choices of answer you have.

[Give respondent show card. Ensure respondent knows what is
expected of him or her. **Stress that the statements apply only
to the marked areas**]

7 [**Note identity of marked area**]   A   B   C   [ ]

The first statement is this:
I think that the marked area is difficult or dangerous to/ walk
on [or if a pushchair etc used] wheel a pushchair on.

How strongly do you agree or disagree with that statement?
8 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

Thank you. Now I'm going to read out some more statements and
ask you how much you agree or disagree with them.   These
questions are about the detail of the marked area so I would
like you to have a good look at the area before you make up your
mind.

The first of these statements is about/ whether too many of the pavers/bricks are broken [or in the case of tarmac] whether the tarmac is too broken up/. Here is the statement:

I don't think that/ too many of the pavers/bricks are broken up [or in the case of tarmac] too much of the tarmac in the area is cracked and broken.

9 How strongly do you agree or disagree with that statement?
   Choose from: SA   A   NAD   D   SD   [DK]   [ ]

[Omit for tarmac] The next statement is about whether the gaps between the pavers/bricks are too wide so that your heel could get stuck in them or trip up over them.

[Omit for tarmac. Ensure that respondent understands that you are not talking about individual broken pavers, but the gaps between pavers]

[Omit for tarmac] Here is the statement: Any gaps in between pavers/bricks in this marked area are acceptable and couldn't catch my stick/wheels/heel or make me trip up.

[Omit for tarmac] How strongly do you agree or disagree with that statement?   Choose from:
10 SA   A   NAD   D   SD   [DK]   [ ]

The next statement is about how even or regular the surface is, that is whether it undulates or tends to bump up and down.

Here is the statement: I think that this marked area is irregular, and tends to be uneven.

11 How strongly do you agree or disagree with that statement?
   Choose from: SA   A   NAD   D   SD   [DK]   [ ]

The next statement is to do with how well any repairs in the marked area have been conducted, that is, whether you think any mending of the footpath in the marked are has been done well enough.

Here is the statement: The repairs in the marked area are inadequate to walk on.

   How strongly do you agree or disagree with that statement?
   Choose from: SA   A   NAD   D   SD   [DK]   [ ]
12 [If "no repairs" then SD]

The next statement on this marked area is to do with/ pavers or bricks [or if tarmac:] surfaces/ that are raised or tilted so that the edges stick up and people trip over them.

Here is the statement. None of the/ pavers or bricks [or if tarmac:] surface/ on this marked area have/has raised edges which can trip people up.

13 How strongly do you agree or disagree with that statement?
   Choose from: SA   A   NAD   D   SD   [DK]   [ ]

The last statement on this marked area is to do with how slippery or easy to grip you find this surface.

Here is the statement. I find that the material in the marked area gives little grip, so I can slip especially when its wet.

How strongly do you agree or disagree with that statement?

14 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

Thanks. Now I'd like us to go to the next marked area.

[Go to marked area and Note identity of marked area]

15 A   B   C   [ ]

I will make the same statements here as I did before. If you are not clear what the statement means, please say so. Please have a good look at the marked area before answering.

I think that the marked area is difficult or dangerous to/ walk on [or if a pushchair etc used] wheel a pushchair on.

16 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I don't think that/ too many of the pavers/bricks are broken up [or in the case of tarmac] too much of the tarmac in the area is cracked and broken.

17 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

[Omit for tarmac] Any gaps in between pavers/bricks in this marked area are acceptable and couldn't catch my stick/wheels/heel or make me trip up.

18 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I think that this marked area is irregular, and tends to be uneven.

19 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

The repairs in the marked area are inadequate to walk on.

Choose from: SA   A   NAD   D   SD   [DK]   [ ]
20 [If "no repairs" then SD]

None of the/ pavers or bricks [or if tarmac:] surface/ on this marked area have/has raised edges which can trip people up.

21 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I find that the material in the marked area gives little grip, so I can slip especially when it's wet.

22 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

Thanks. Now I'd like us to go to the last marked area.   -

23 [Go to marked area]
[Note identity of marked area]   A   B   C   [ ]

I will make the same statements here as I did before. If you are not clear what the statement means, please say so. Please have a good look at the marked area before answering.

I think that the marked area is difficult or dangerous/ to walk on [or, if a pushchair etc used] wheel a pushchair on.

24 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I don't think that/ too many of the pavers/bricks are broken up [or in the case of tarmac] too much of the tarmac in the area is cracked and broken.

25 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

[Omit for tarmac] Any gaps in between pavers/bricks in this marked area are acceptable and couldn't catch my stick/wheels/heel or make me trip up.

26 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I think that this marked area is irregular, and tends to be uneven.

27 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

The repairs in the marked area are inadequate to walk on.

28 Choose from: SA   A   NAD   D   SD   [DK]   [ ]
[If "no repairs" then SD]

None of the/ pavers or bricks [or if tarmac:] surface/ on this marked area have/has raised edges which can trip people up.

29 Choose from: SA   A   NAD   D   SD   [DK]   [ ]

I find that the material in the marked area gives little grip, so I can slip especially when it's wet.

30 How strongly do you agree or disagree with that statement?
Choose from: SA   A   NAD   D   SD   [DK]   [ ]

Thanks very much for your co-operation.

APPENDIX B

Definition of Methods of Measurement of Objective Variables

Length of Gaps: The edge of each paver or block was examined in relation to the adjoining paver or block using a width gauge developed for the purpose (see photograph). Where the gap exceeded 5 mm the gap was examined to find which category it fell into: 5-10 mm, 10-15 mm, 15-20 mm, >20 mm. Because some gaps can be so shallow that they may be regarded as giving no cause for concern a minimum depth of 5 mm between two pavers or blocks for the length of the gap was required before a measurement was taken. A note was then taken of the length of the gap. Gaps often extended for the whole length of the paver, in which case the fact was noted, for ease of recording. Where the gap extended for, say, half the length of the paver, that was also noted. The length and category of each gap in each area was found and totalled, giving the total length of various widths of gap in each area. Tarmac sites were not included in the measurements.

Length of Height Differences: The method employed to measure the length of height difference was determined in exactly the same manner as for the length of gaps, except that a specially made depth gauge was used, and there was no category for 15-20 mm. All measurements of over 15 mm were grouped together. Tarmac sites were not included in measurements.

Percentage of Broken Elements: The number of pavers that were broken or cracked within each area was counted and the percentage of the total number of pavers in each area calculated. Small chips or cracks at the edges or corners of pavers were not included.

Undulation: The areas were marked with a grid pattern at 0.5m intervals. At each node the height from a horizontal plane, found by use of a laser level, was measured and recorded. The degree of undulation was found by comparing the recorded height of each node to the height of the node that would be found if there were no undulation. The height of each node that would be found if there was no undulation was defined as the mean height of the four adjacent nodes. (Calculated heights of nodes in corners of the grid were extrapolated from the recorded heights of the two nearest nodes on each of the adjacent edges, and nodes on the edge of an area were calculated from the adjacent nodes also on the edge of the area, and by extrapolating from the two nearest nodes at right angles to the edge.) Thus the calculated height of each node depended on the actual height of nodes in the near vicinity, so any overall gradient of the area would not result in an undulation being found, and any shift in the overall orientation of the area would affect the overall result only slightly. To obtain the final measure of undulation for each area, the standard error of estimate of the nodes was calculated.

Slip Resistance: No completely suitable equipment for measuring, on site, the slip resistance of footwear on paving material has been found. The slip resistance was measured, however, using the portable skid-resistance tester described in TRRL Road Note 27 that is intended for measuring the skid-resistance between a vehicle tyre
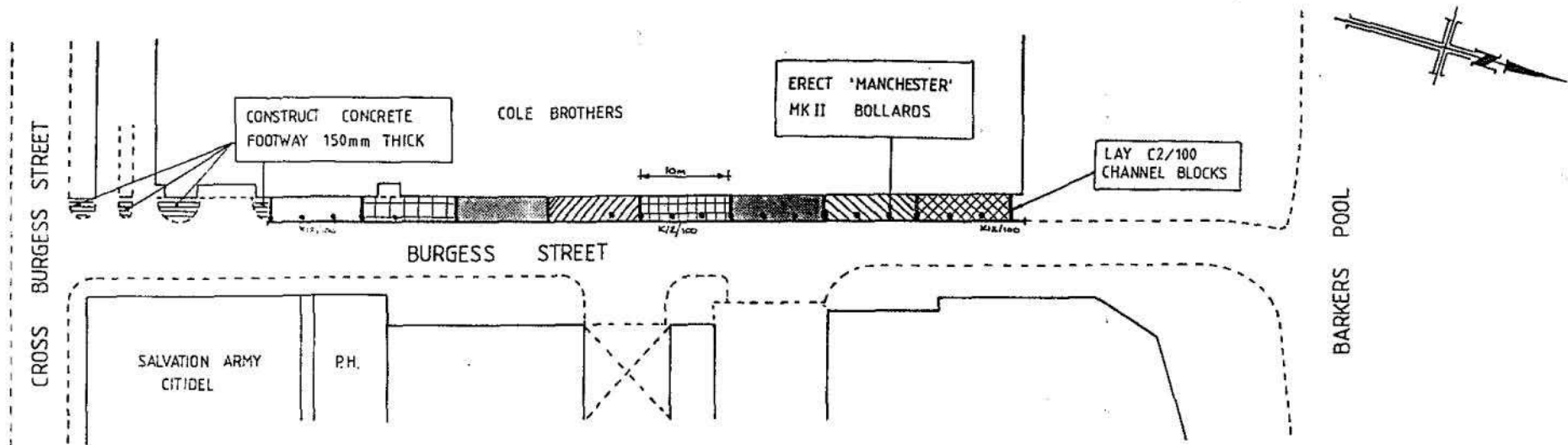
and road at 50 km/h. This method was used in earlier work in Leeds and appears to give results of some value.
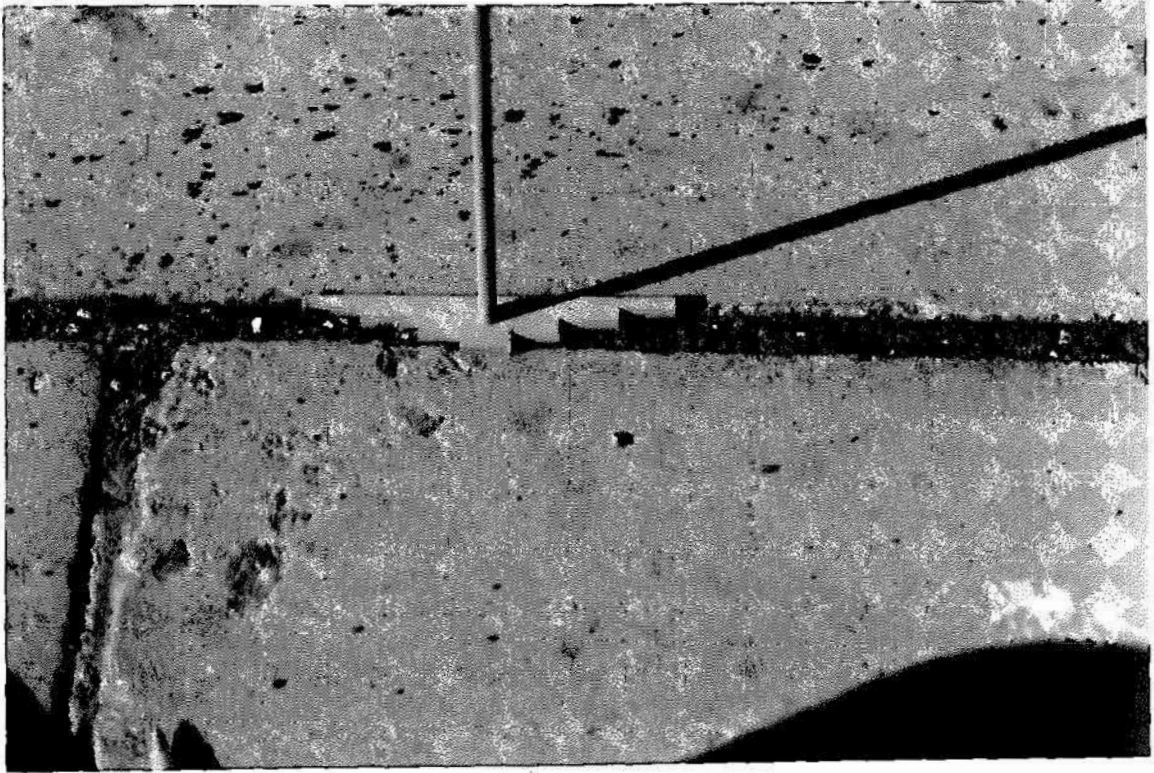
Width gauge for measuring the length of gap of a specified size

APPENDIX D

Layout Details of the Surfacing Materials used in
the Stage 3 Trial Site at Barkers Pool,
Sheffield City Centre

CONSTRUCT CONCRETE FOOTWAY 150mm THICK

COLE BROTHERS

ERECT 'MANCHESTER' MK II BOLLARDS

LAY C2/100 CHANNEL BLOCKS

10m

CROSS BURGESS STREET

BURGESS STREET

BARKERS POOL

SALVATION ARMY CITIDEL

P.H.

D. 1

KEY

CONCRETE 'KEYBLOCK' PAVING 65mm THICK GREY COLOUR TYPE 6 LAID ON 100mm SUB BASE / 25mm SAND BED

CONCRETE 'PENCIL ROUNDED KEYBLOCK' PAVING 65mm THICK GREY COLOUR TYPE 6 LAID ON 100mm SUB BASE / 25mm SAND BED

1 COAT OF COARSE 3mm SLURRY SEAL
50mm THICK LAYER OF 20mm DENSE BIT BASECOURSE (SPEC 31)
100mm THICK LAYER OF TYPE 1 SUB BASE

15mm THICK LAYER OF MEDIUM GRADED WEARING COURSE (SPEC 22)
40mm THICK LAYER OF 20mm DENSE BIT BASECOURSE (SPEC 31)
100mm THICK LAYER OF TYPE 1 SUB BASE

40mm THICK LAYER OF 10mm 'WARDTITE' WEARING COURSE
100mm THICK LAYER OF TYPE 1 SUB BASE

GROUP 22 FLAGGED FOOTWAY (900 × 600 × 50mm P.C.C. FLAGS GREY COLOUR LAID ON 100mm SUB BASE / 25mm SAND BED

450 × 450 × 50mm SMALL ELEMENT P.C.C. PAVING FLAGS GREY COLOUR LAID ON 100mm SUB BASE / 25mm SAND BED

450 × 450 × 70mm 'TRAFFICA' SMALL ELEMENT P.C.C. PAVING FLAGS (CHAMFERED) GREY COLOUR LAID ON 100mm SUB BASE / 25mm SAND BED

K12/100 EXCAVATE AND DISPOSE EXISTING KERBS LAY NEW K12/100 KERBS TO 125mm UPSTAND.

BURGESS STREET	AMENDMENTS	DATE	SHEFFIELD WORKS DEPARTMENT ENGINEERING DIVISION HIGHWAY MAINTENANCE	DRG No. 1
FOOTWAY TRIALS				SCALE 1:500
				DATE JULY 1989

R7858/1

APPENDIX E

Photographs of the Stage 3 Trial Site at
Barkers Pool, Sheffield City Centre

APPENDIX F

Stage 3 Interview Form

SHEFFIELD STAGE3   SURVEY FORM   DRAFT 4   20/9/89

[Record Date:]
_____

[Record Site:]
_____

[Record Interviewer's name:]
_____

Excuse me, we are doing a street survey for the Council.
Are/Would you (mind) walking along here? Can I ask you some
questions on the different surfaces? We want to see which
pavements people like so the Council will know what to lay in the
future. Everybody who helps is entered in a draw with a first
prize of £100 and three more prizes of £20 each. It will only
take a few minutes to do the interview.

[Give assurances as appropriate on confidentiality and brevity
of interview.]

[Determine whether respondent is about to walk along the route
anyway]
            Yes   No
_____

Sex: M   F
_____

Age: <21   21-30   31-40   41-50   51-60   61-70   71+
_____

Able Bodied greater than, or equal to 51 1
Able Bodied less than 51 2
Disadvantaged (stick, wheelchairs, other aids to walking). 3
Disadvantaged (prams, pushchairs, luggage, children) . . . 4
_____

[Take respondent to first area. Explain that you want the
respondent to look at the marked area. Use "footpath",
"pavement" or whatever term the respondent uses.]

I'm going to read out a statement about pavements. Using this
card I want you to say whether you agree or disagree with the
statement. Feel free to disagree or agree with any of the
statements as strongly as you like.

[Give respondent show card. Ensure respondent knows what is
expected of him or her. <u>Stress that the statements apply only
to the marked areas, and in their present condition</u>]

Here is the first/next/last area:

Version 1

I think that the marked area is difficult to walk on.

How strongly do you agree or disagree?

[If NAD A or SA:]

Version 2

I think that the marked area is not difficult to walk on.

How strongly do you agree or disagree?

[If NAD D or SD:]

What is it about the surface that you think could be difficult?

[Put 1 for each variable mentioned, or place in "other"]

[If respondent unable to explain problem with surface **note the fact** with a "1" by prompt, and read out prompt:]

Is it gaps between pavers, or too many raised edges, or not enough grip, or too much unevenness, or something else?

Sequence	1	2	3	4	5	6	7	8
Area								
SA A NAD D SD DK								
Prompt								
Gaps								
Raised edges								
Slip								
Uneven								

Other (please write, **and identify site to which it applies**)

Now that you have seen all the surfaces, I would like you to say which you liked best and which you liked worst for ease of walking on. Try and list them in order of preference.

[Stress that it is ease of walking on that is being considered, and that it is only the marked areas in their present condition being considered.]
[Walk over areas again and/or show respondents photos.]

Remember, it is only these areas in their present condition that I am asking about, not similar areas elsewhere that may be broken up.

Now   Worst 1   2   3   4   5   6   7   8 Best

Future Worst 1   2   3   4   5   6   7   8 Best

[Attempt to get respondents to rank preferences. If respondent is finding this difficult, attempt to get the two best and two worst. If respondent finds no difference between a group of areas, then bracket them together.]

What do you like about the area?
[Record key-words; avoid vague comments such as "better surface to walk on," and probe for why it is a better surface.]

What do you dislike about the worst area? [Record key-words. Probe as above]

[Record unprompted comments on any of the other surfaces here. note which surface comments relate to]

How do you think that the order of preference might change in a couple of years?
[Fill in against Future]
[If different:]
Why has the order changed?

Now I would like to ask you about which of these you would like
the look of the most and least in these places:

	like most			like least	
	1	2		7	8
an area full of historic buildings such as Paradise Square					
a modern shopping area such as Barkers Pool					
a modern housing estate					
a Victorian street of terraced houses					
a village street					

key:
10   small flag unspecified
11   small flag chamfer   (A)
12   small flag pencil arris (B)
20   large flag (C)
30   tarmac unspecified
31   new style tarmac (D)
32   standard tarmac (E)
33   slurry seal tarmac (F)
40   block unspecified
41   block pencil arris (G)
42   block chamfer (H)
50   other (please note)

Finally, do you like or dislike seeing footpaths in these
colours?
[tick a 1 for "like" a 2 for "dislike" and a 3 for "no
preferences"]

black
brick red
grey
sand
other [please specify]
depends on surroundings

Please give your name and address so that we may contact you if
you are one of the winners.

Name .... Tel: ....

Address ....

        ....

        ....

Stage 2 Detailed Results

KEY

Ability Group	1	Elderly mobile (> 50 years old, without walking aid)
	2	Young mobile ($\leq$ 50 years old, without walking aid)
	3	Disadvantaged (disabled)
	4	Disadvantaged (encumbered)

Sex	M	Male
	F	Female

Age Group	<31	Below 31 years of age
	31-60	31 - 60 years of age (inclusive)
	>60	Above 60 years of age

* Result based on weak relationship
– No clear relationship produced

1   Undulation Results

TABLE G.1   UNDULATION THRESHOLD VALUES - ALL USERS

Surface	Undulation Measure (cms)			
	Sea 1	Mada 1	Sea 2	Mada 2
Block paving	9*	—	—	3
Conventional flags	11	7	14*	5.5
Small element flags	10	6	7	5.5
Black top	16*	11*	—	—

TABLE G.2 UNDULATION THRESHOLD VALUES - BY ABILITY GROUP

Surface	Ability Group	Undulation Measure (cms)			
		Sea 1	Mada 1	Sea 2	Mada 2
Block paving	1	8	—	6*	—
	2	10*	—	6*	—
	3	16*	—	6	—
	4	12*	—	5	5.0*
Conventional flags	1	11	8	10	5.5*
	2	10	7	—	4.0*
	3	13*	8	22*	7.0
	4	12	8	10	6.0
Small element flags	1	9	6	10	4.0
	2	10	6	8	7.5*
	3	—	9	12*	7.5
	4	11	7	11*	6.0
Black top	1	12*	10*	—	—
	2	16*	17*	—	—
	3	22	18	13*	—
	4	12*	15*	14*	—

TABLE G.3 UNDULATION THRESHOLD VALUES - BY SEX

Surface	Sex	Undulation Measure (cms)			
		Sea 1	Mada 1	Sea 2	Mada 2
Block paving	M	–	–	10	7.0*
	F	–	13*	6	–
Conventional flags	M	11	7	10	5
	F	17*	7	–	6.5*
Small element flags	M	11	6	12*	4.5
	F	12	7	–	–
Black top	M	15*	10*	–	3.0*
	F	19*	11*	–	–

TABLE G.4 UNDULATION THRESHOLD VALUES - BY AGE GROUP

Surface	Age Group	Undulation Measure (cms)			
		Sea 1	Mada 1	Sea 2	Mada 2
Block paving	<31	–	–	5*	–
	31-60	–	–	5	3.3*
	>60	–	–	5	–
Conventional flags	<31	9	6	6*	3.8*
	31-60	10	6	6*	4.0*
	>60	13	7	6	5.5*
Small element flags	<31	9	6	–	4.5*
	31-60	10	6	6*	4.0*
	>60	11	7	7	4.9
Black top	<31	10*	–	–	–
	31-60	10*	8*	–	–
	>60	14*	11*	12*	6.0*

2 Raised Edge Results

TABLE G.5 RAISED EDGE THRESHOLD VALUES - ALL USERS

	Tilt Measure (%)		
	Tila 1 (>5mm)	Tila 2 (>10mm)	Tila 3 (>15mm)
Block paving	0.7	–	–
Conventional flags	–	1.6*	–
Small element flags	9.5	1.0	–
Black top	N/A	N/A	N/A

TABLE G.6 RAISED EDGE THRESHOLD VALUES - BY ABILITY GROUP

Surface	Ability Group	Tilt Measure (%) Tila 1	Tila 2	Tila 3
Block paving	1	0.7	–	–
	2	0.7	–	–
	3	0.7	–	–
	4	0.7	–	–
Conventional flags	1	11.3*	2.0	–
	2	12.1*	2.4*	–
	3	12.9*	1.2*	–
	4	12.1*	2.0*	–
Small element flags	1	8.3	1.2	–
	2	8.3	1.2*	–
	3	6.0	0.4*	–
	4	10.1	1.2*	–
Black top	–	N/A	N/A	N/A

TABLE G.7 RAISED EDGE THRESHOLD VALUES - BY SEX

Surface	Sex	Tilt Measure (%) Tila 1	Tila 2	Tila 3
Block paving	M	0.8	–	–
	F	0.7	–	–
Conventional flags	M	12.1*	2.6	–
	F	13.7*	2.3*	–
Small element flags	M	8.9	1.2*	–
	F	7.1	1.0*	–
Black top	–	N/A	N/A	N/A

TABLE G.8 RAISED EDGE THRESHOLD VALUES - BY AGE

Surface	Age Group	Tilt Measure (%)		
		Tila 1	Tila 2	Tila 3
Block paving	<31	0.7	–	–
	31–60	0.8	–	–
	>60	0.8	–	–
Conventional flags	<31	11.3*	2.4*	–
	31–60	12.1*	2.1*	–
	>60	12.9*	2.4*	–
Small element flags	<31	9.5*	1.8*	–
	31–60	7.1	–	–
	>60	11.9	–	–
Black top	–	N/A	N/A	N/A

3 Friction Results

TABLE G.9 FRICTION THRESHOLD VALUES - ALL USERS

Surface	Friction Measure
Block paving	66
Conventional flags	62*
Small element flags	65*
Black top	68

TABLE G.10   FRICTION THRESHOLD VALUES - BY ABILITY GROUP

Surface	Ability Group	Friction Measure
Block paving	1	65
	2	65
	3	68
	4	65
Conventional flags	1	70
	2	65
	3	65
	4	65*
Small element flags	1	-
	2	62*
	3	-
	4	-
Black top	1	70
	2	68*
	3	68*
	4	70

TABLE G.11   FRICTION THRESHOLD VALUES - BY SEX

Surface	Sex	Friction Measure
Block paving	M	65
	F	67
Conventional flags	M	65
	F	67
Small element flags	M	-
	F	-
Black top	M	68*
	F	67*

TABLE G.12   FRICTION THRESHOLD VALUES - BY AGE

Surface	Age Group	Friction Measure
Block paving	<31	65
	31-60	65
	>60	65
Conventional flags	<31	—
	31-60	70
	>60	65
Small element flags	<31	65*
	31-60	—
	>60	65
Black top	<31	—
	31-60	—
	>60	—

4 Broken Paver Results

TABLE G.13   BROKEN PAVERS THRESHOLD VALUES - ALL USERS

Surface	% Broken Pavers
Block paving	–
Conventional flags	10
Small element flags	–
Black top	N/A

5 Gaps Results

TABLE G.14   GAPS THRESHOLD VALUES - ALL USERS

Surface	Gap Measure (%)			
	Gapa 5 (>5mm)	Gapa 10 (>10mm)	Gapa 15 (>15mm)	Gapa 20 (>20mm)
Block paving	-	-	-	-
Conventional flags	-	2.4*	-	-
Small element flags	-	-	0.3*	-
Black top	N/A	N/A	N/A	N/A

TABLE G.15   GAPS THRESHOLD VALUES - BY ABILITY GROUP

Surface	Ability Group	Gap Measure (%)			
		Gapa 5	Gapa 10	Gapa 15	Gapa 20
Block paving	1	-	-	-	-
	2	-	-	-	-
	3	-	-	-	-
	4	-	-	-	-
Conventional flags	1	54.8*	4.0	0.8	-
	2	-	3.2*	0.8	-
	3	56.5	4.8*	0.8	-
	4	53.2*	0.8*	-	-
Small element flags	1	-	-	0.06	-
	2	-	-	0.06	-
	3	-	-	-	-
	4	-	-	-	-
Black top	-	N/A	N/A	N/A	N/A

TABLE G.16   GAPS THRESHOLD VALUES - BY SEX

Surface	Sex	Gap Measure (%)			
		Gapa 5	Gapa 10	Gapa 15	Gapa 20
Block paving	M	-	-	-	-
	F	-	-	-	-
Conventional flags	M	12.9*	4.8	0.8	-
	F	8.1*	0.8	-	-
Small element flags	M	-	-	-	-
	F	-	-	-	-
Black top	-	N/A	N/A	N/A	N/A

TABLE G.17   GAPS THRESHOLD VALUES - BY AGE

Surface	Age Group	Gap Measure (%)			
		Gapa 5	Gapa 10	Gapa 15	Gapa 20
Block paving	<31	–	–	–	–
	31-60	–	–	–	–
	>60	–	–	–	–
Conventional flags	<31	54.8*	3.2	–	–
	31-60	51.6*	3.2	–	–
	>60	46.0*	1.6	–	–
Small element flags	<31	–	–	0.06	–
	31-60	–	–	0.06	–
	>60	–	–	unacceptable	
Black top	–	N/A	N/A	N/A	N/A

APPENDIX H

Stage 3   Detailed Results

TABLE H.1 PERCENTAGE OF MALES/FEMALES FINDING AREA DIFFICULT TO WALK UPON

AREA

	SA	A	NA	D	SD
A	3/4	53/57	0/1	43/38	0/0
B	7/6	57/50	0/0	35/43	2/0
C	3/2	62/62	0/1	35/36	0/0
D	3/2	53/60	0/0	43/36	0/2
E	5/7	48/43	0/0	42/36	5/7
F	3/2	50/66	0/2	47/29	0/2
G	8/7	58/50	0/0	33/41	0/2
H	5/11	60/56	0/1	35/30	0/2

KEY

SA   - strongly agree that site is difficult
A   - agree
NA   - neither agree nor disagree
D   - disagree
SD   - strongly disagree

3/4 3% males interviewed
     4% females interviewed

TABLE H.2 PERCENTAGE OF EACH ABILITY GROUP FINDING AREA DIFFICULT TO WALK UPON

ABILITY GROUP	SA				A				NA				D				SD			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
AREA																				
A	4	7	4	0	51	64	57	50	0	2	0	0	45	27	39	50	0	0	0	0
B	10	11	0	2	47	48	64	56	0	0	0	0	41	41	36	42	2	0	0	2
C	4	4	0	0	49	66	71	64	2	0	0	0	45	30	29	36	0	0	0	0
D	2	4	4	0	53	61	54	62	0	0	0	0	39	36	43	38	6	0	0	0
E	6	6	4	6	29	52	54	48	0	0	0	0	37	41	39	34	8	2	4	12
F	2	4	4	0	61	64	54	60	0	2	0	2	31	30	43	38	6	0	0	0
G	10	13	0	4	47	48	64	58	0	0	0	0	43	40	36	34	0	0	0	4
H	4	18	4	8	53	57	61	60	0	0	0	2	41	25	36	26	2	0	0	4

KEY

SA	- strongly agree that site is difficult
A	- agree
NA	- neither agree nor disagree
D	- disagree
SD	- strongly disagree

TABLE H.3 ADDITIONAL COMMENTS FOR THE AREA LIKED MOST (FREQUENCY)

Comments	Area A	B	C	D	E	F	G
Even	1	1	1	-	-	-	-
No edges	1	1	1	2	2	2	-
No gaps	-	1	1	2	2	2	-
Too smooth	-	-	-	1	1	1	-
Good grip	1	-	1	-	-	-	1
Smooth	-	-	-	-	2	-	-
Not slippery	1	1	-	-	-	-	-
Raised edges	-	1	1	-	-	-	-

TABLE H.4 ADDITIONAL COMMENTS FOR THE AREA LIKED LEAST (FREQUENCY)

Comment	A	B	C	D	E	F	G	H
Slippery in winter	1	1	1	1	1	1	-	-
Unattractive	-	-	-	-	-	-	1	1
Raised edges	1	2	7	-	-	-	-	-
Gaps	1	-	-	-	-	-	4	6
Smooth	-	-	-	1	1	1	-	-
Could trap wheels	-	-	1	-	-	-	-	-
Old fashioned	-	-	1	-	-	-	-	-
Bad edges	1	2	2	-	1	-	1	1
Uneven	-	-	3	-	-	-	-	-
Will break	-	-	1	-	-	-	-	-
Will crack	-	-	1	-	-	-	-	-

TABLE H.5 ADDITIONAL COMMENTS RELATING TO EACH AREA

Comments	A	B	C	D	E	F	G	H
Slippery in winter	1	1	-	-	2	2	-	-
Bumpy	-	-	-	-	-	-	-	1
Even	1	2	1	-	-	-	1	1
No edges	1	-	-	-	-	-	-	1
Gaps	3	-	-	-	-	-	-	5
Easy to repair	1	1	1	-	-	-	2	-
Slabs will lift up	-	1	1	-	-	-	-	-
Uneven	-	-	1	-	-	-	-	-
Raised edges	-	-	1	-	-	-	-	-
Bad edges	-	-	2	-	-	-	-	-
Will break up	-	-	1	-	-	-	-	-
Soft	-	-	1	-	-	-	-	-
Will crack in time	-	-	1	-	-	-	-	-
Heels sink in/get stuck	-	-	-	5	3	3	-	1
Sticky in summer	-	-	-	1	1	1	-	-
Smooth	-	-	-	2	3	2	-	-
Tarmac will break up	-	-	-	1	1	1	-	-
Good grip	-	-	-	-	-	-	1	1

View from Barkers Pool

View from Cross Burgess Street

APPENDIX C

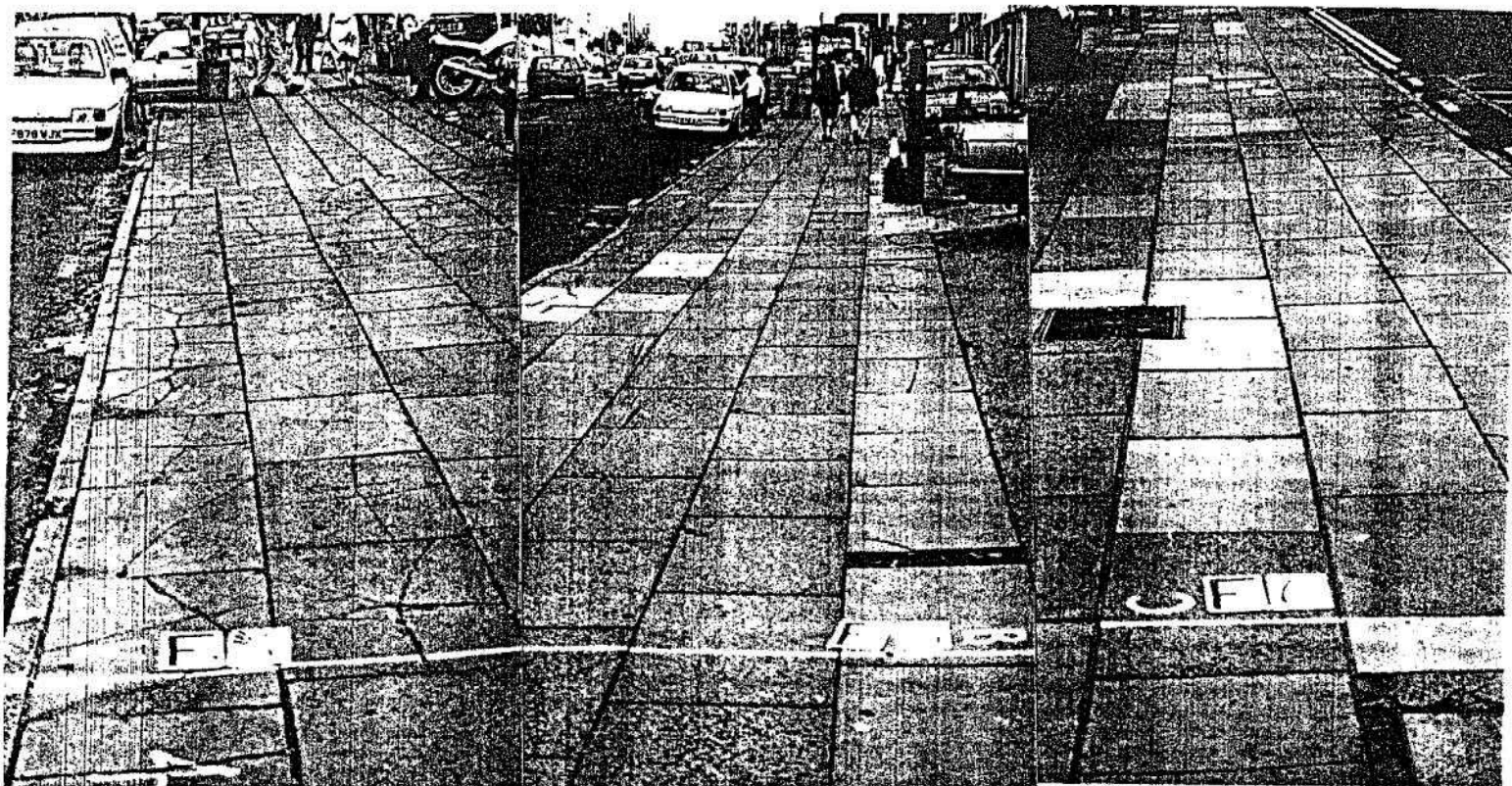Photographs of the Study Areas
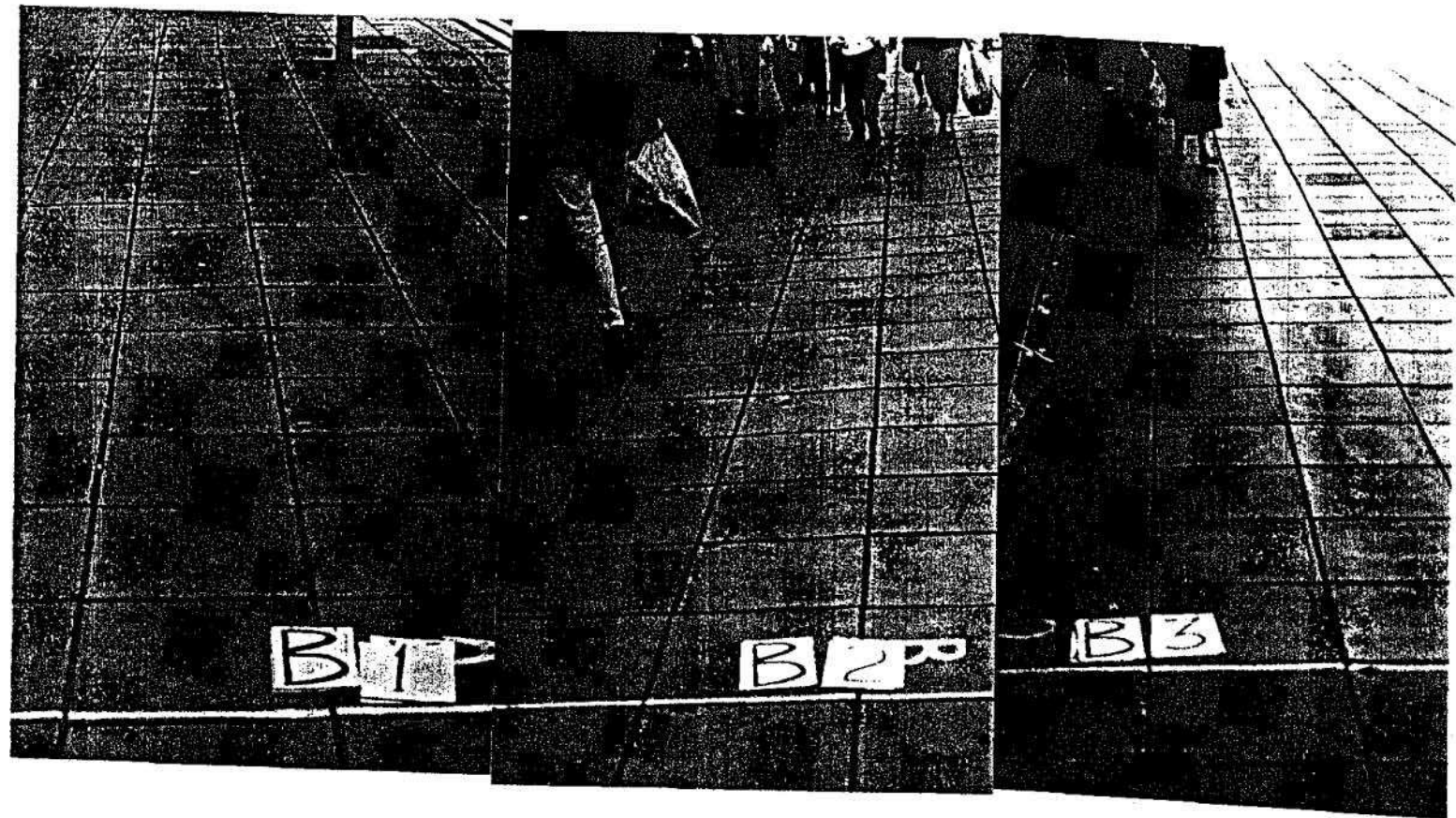
1. Pinstone Street
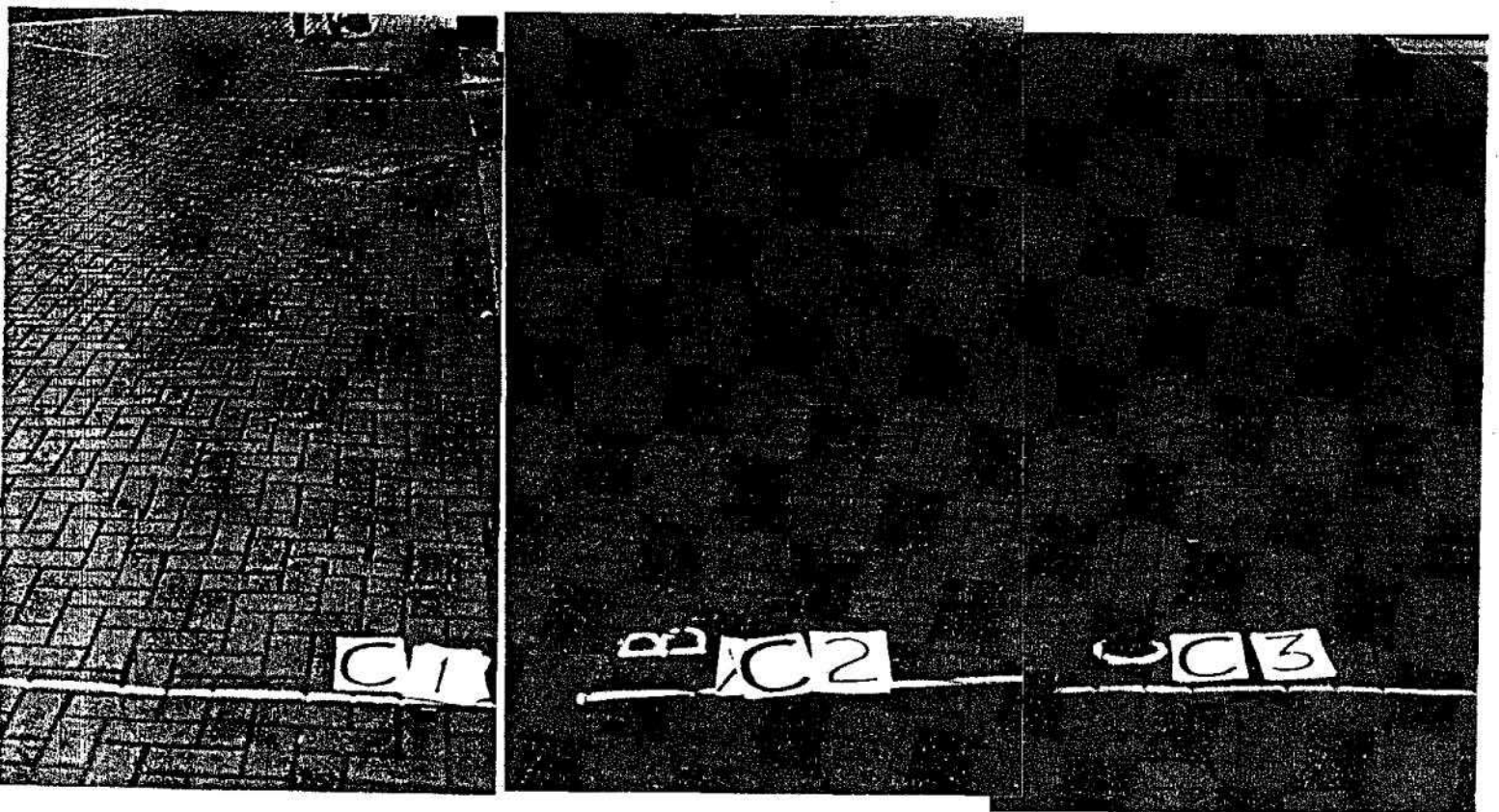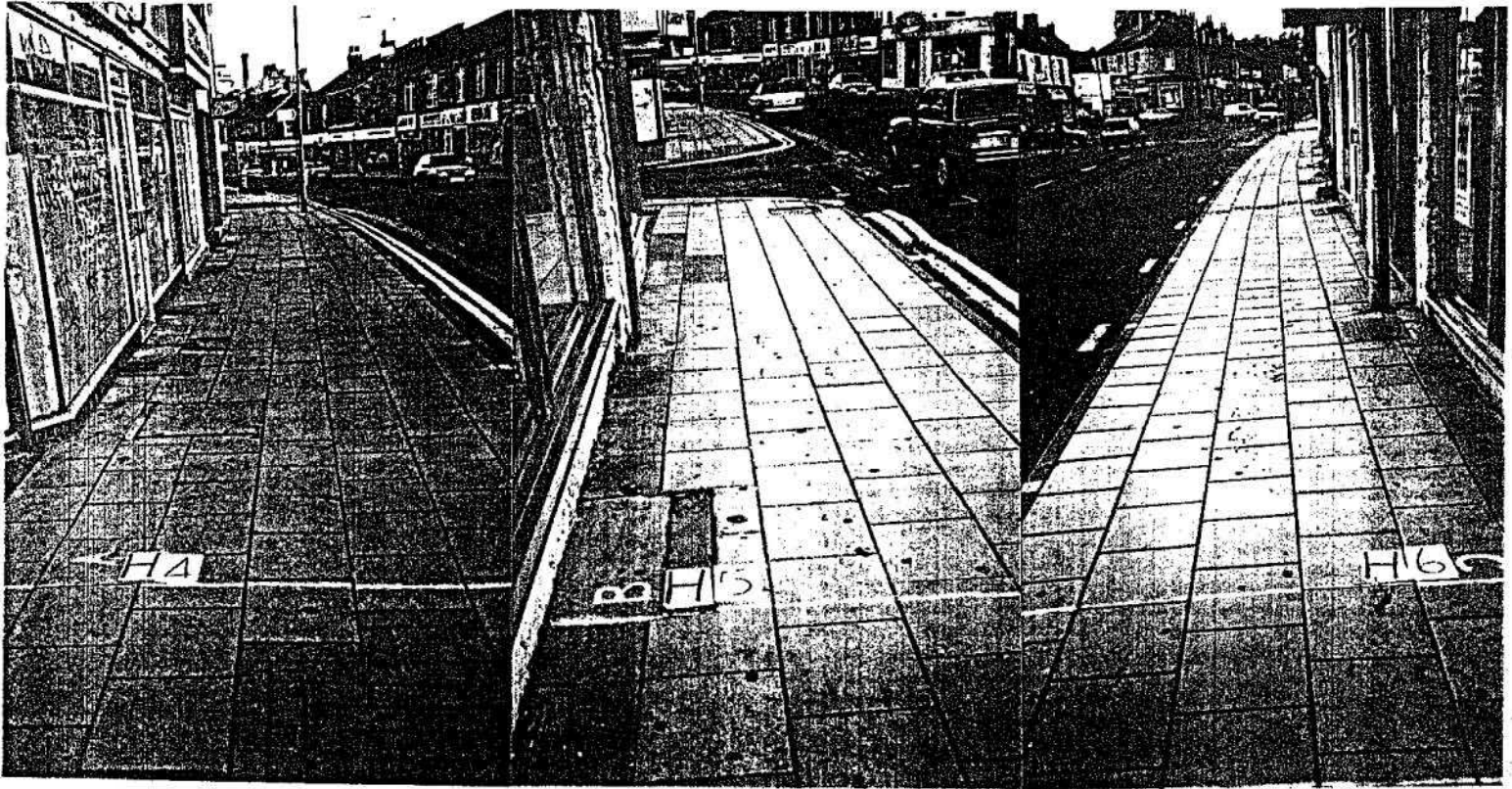

2. Moor/Fitzwilliam Gate
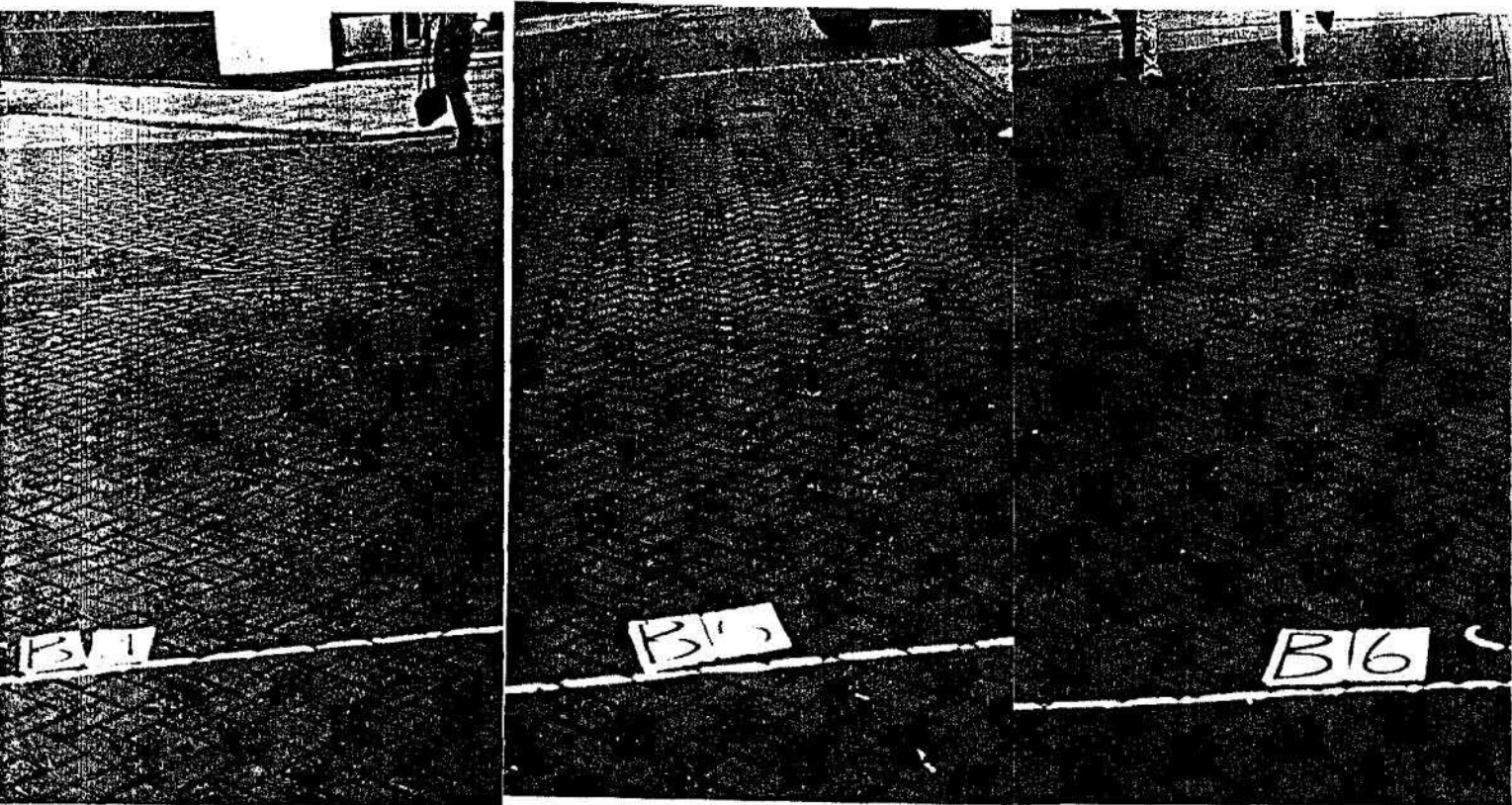
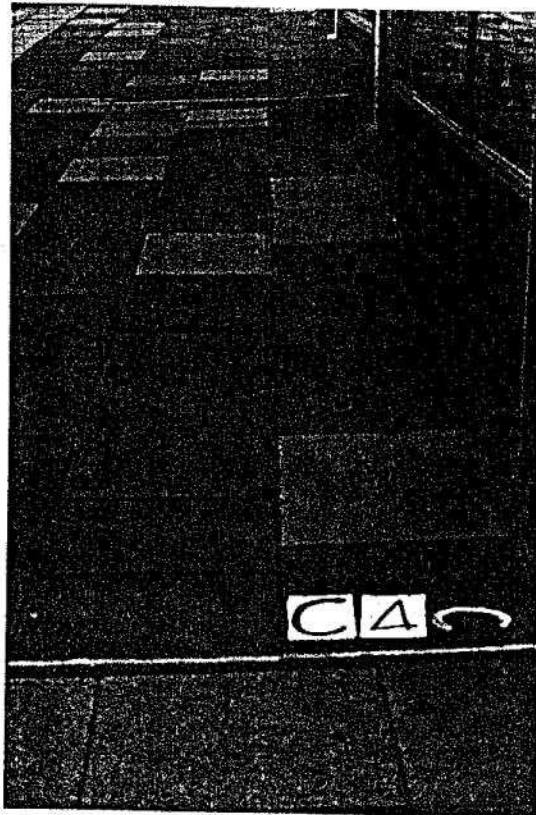3. Moor (Marks and Spencers)
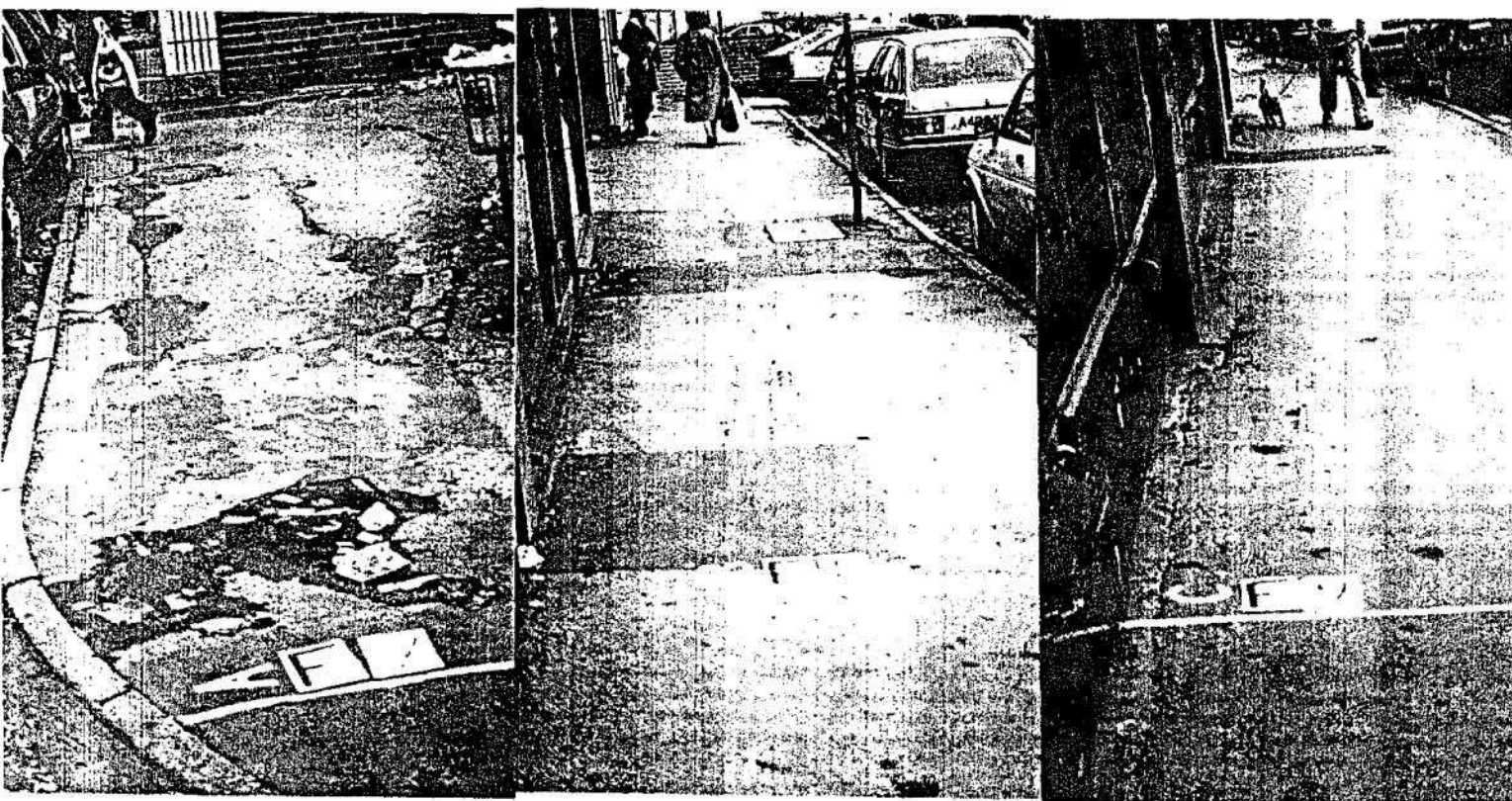
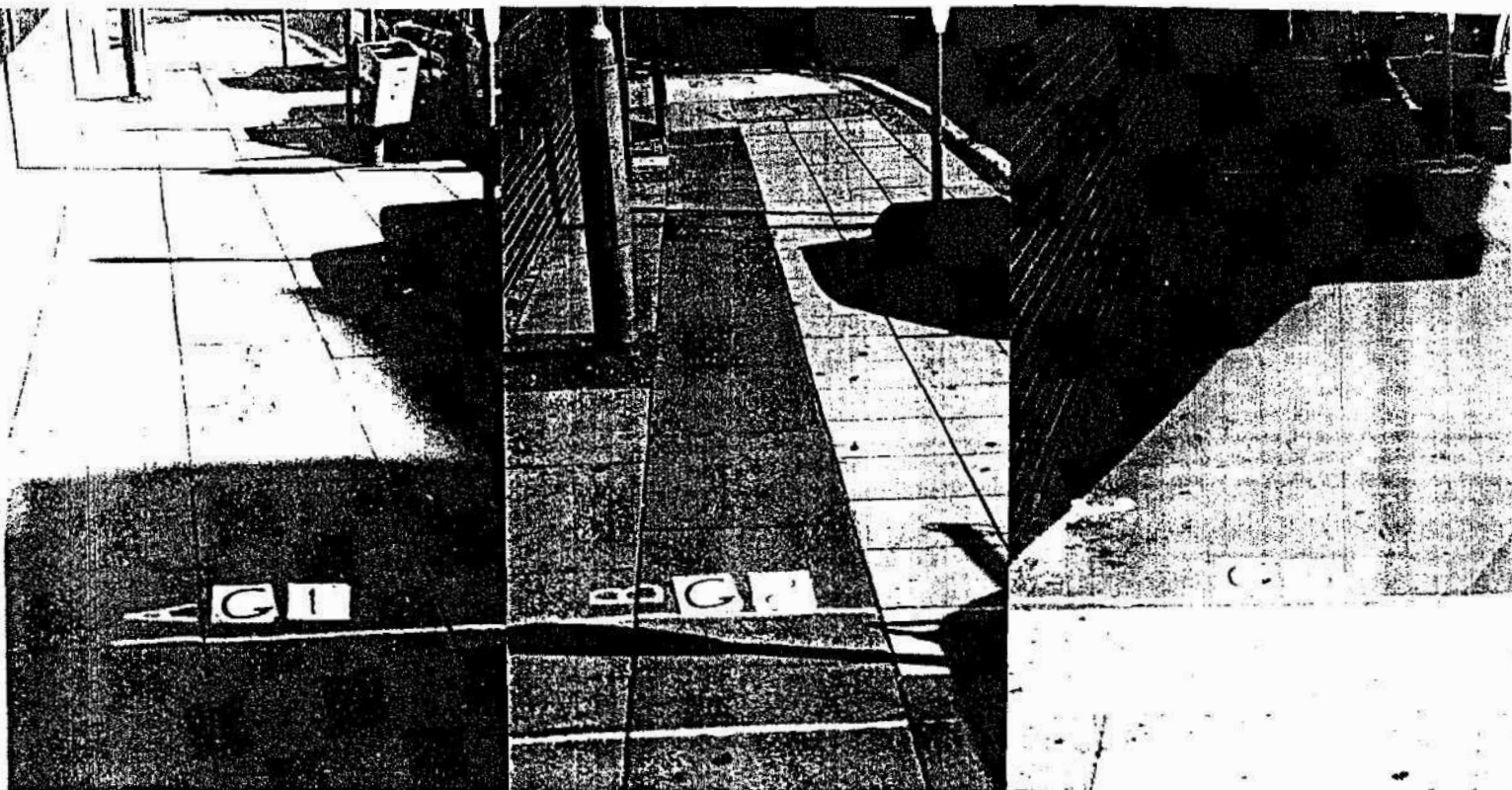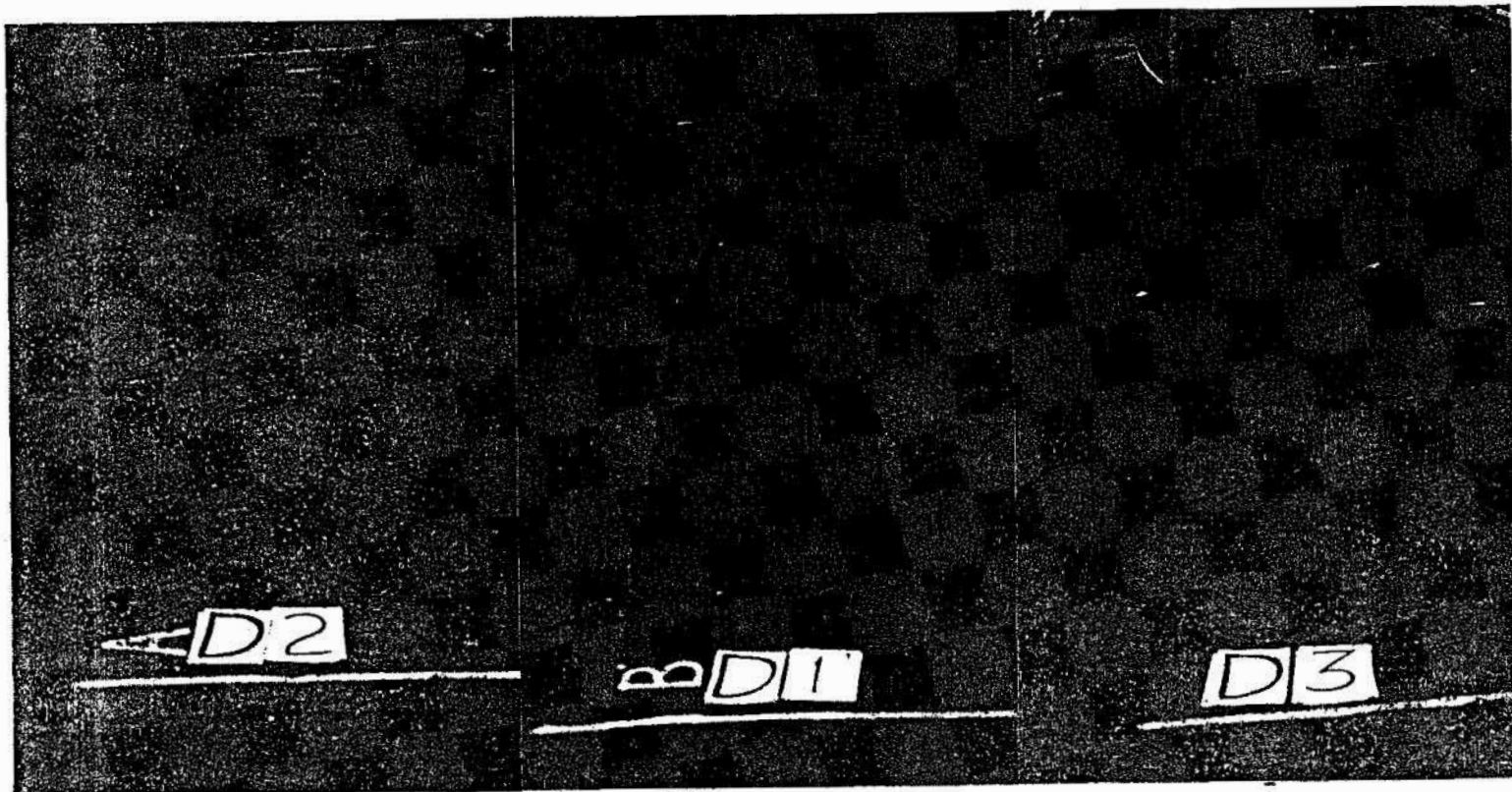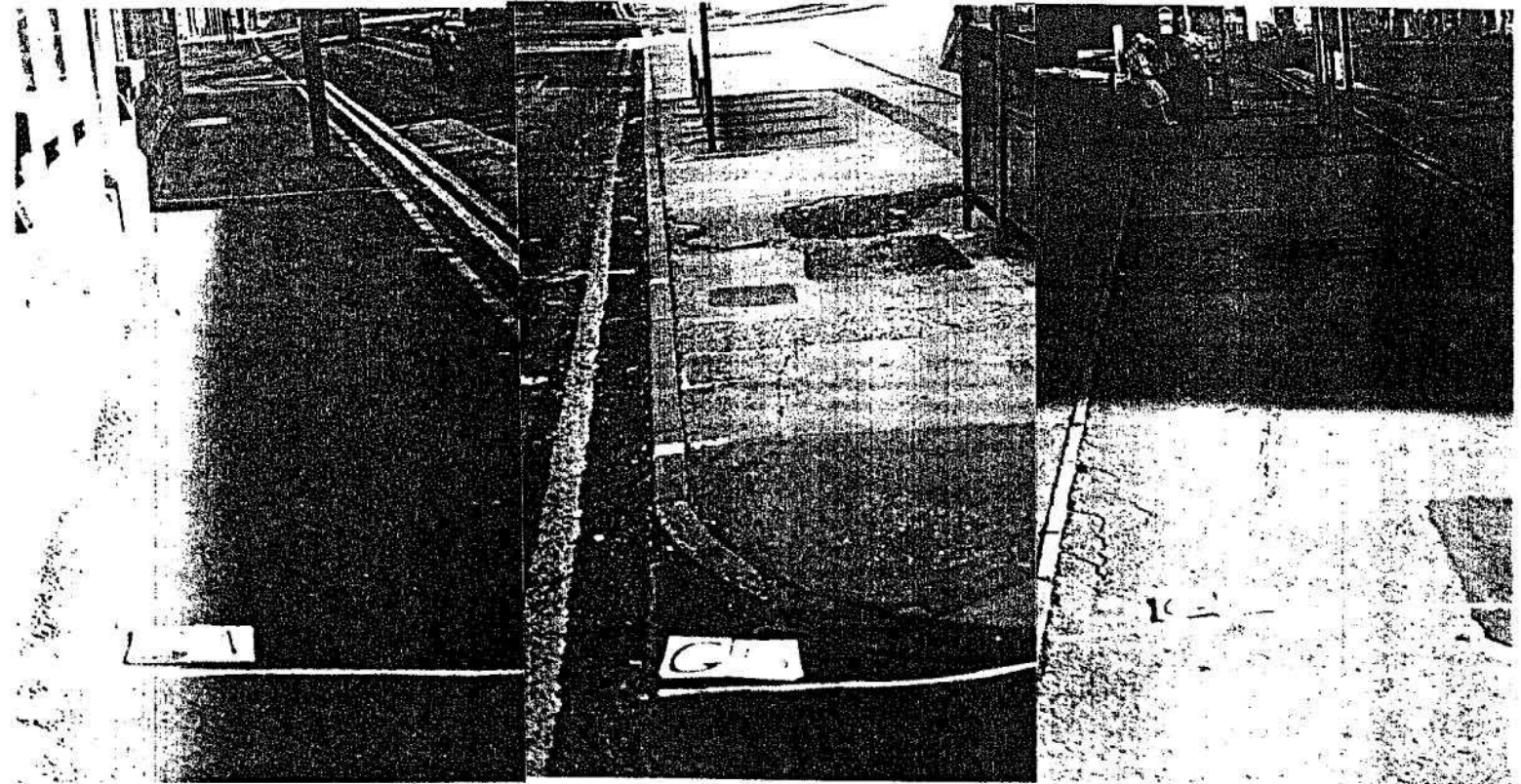4. Manor Top

5.   Manor Top

6.   Eccleshall

7.   Langsett Road/Hillsborough

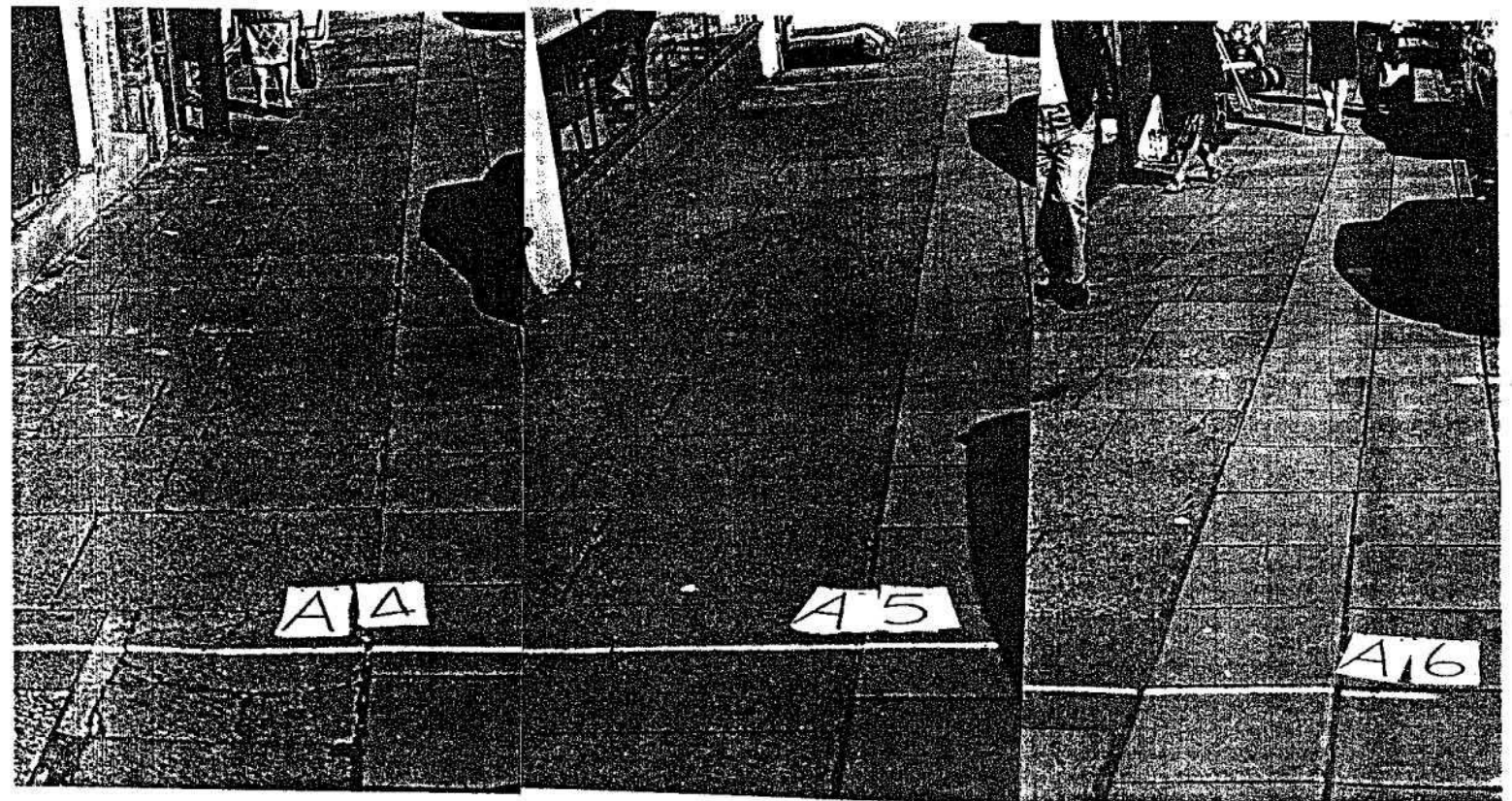8.   Moor/Fitzwilliam Gate
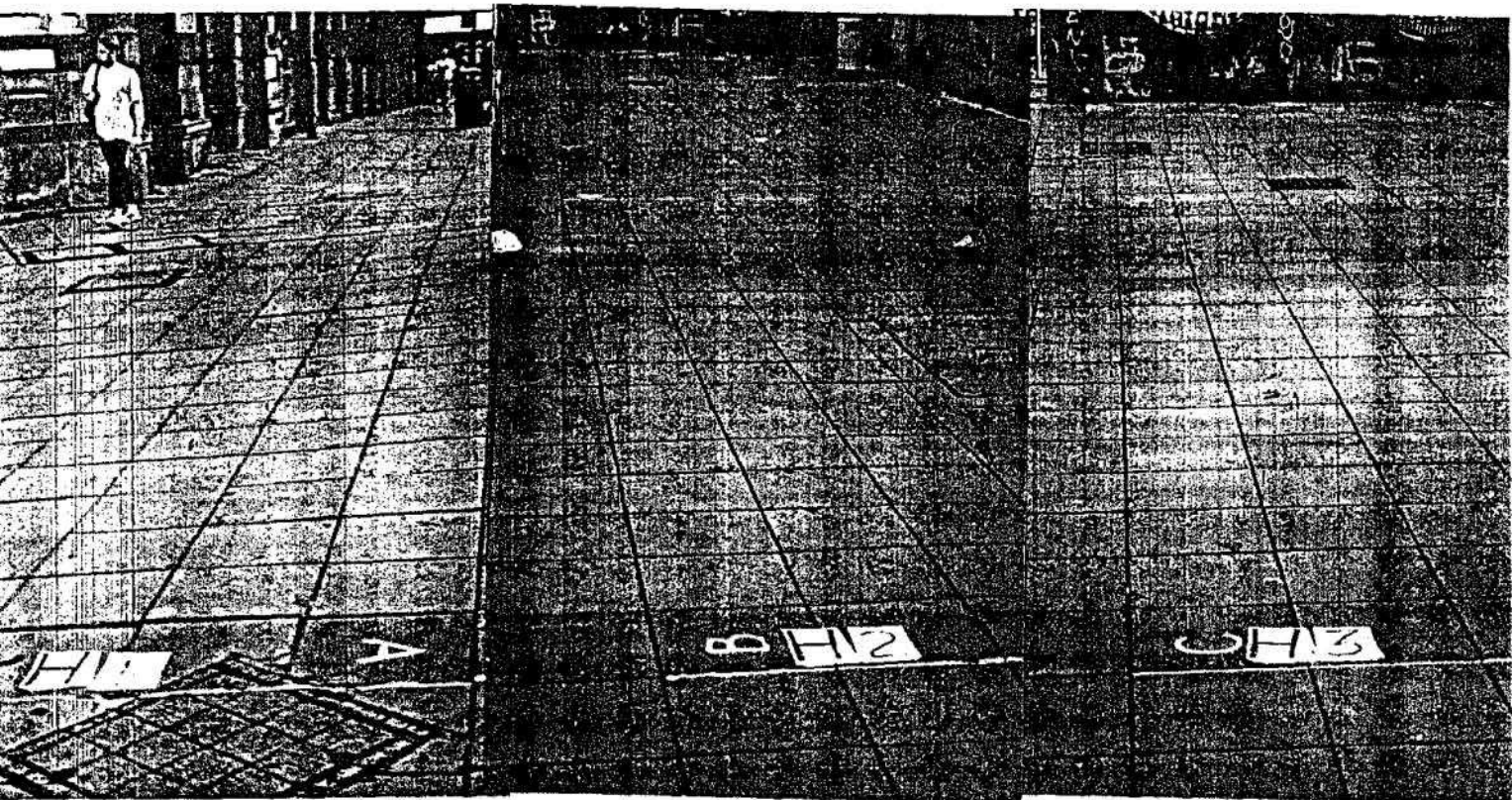   (flag site only)

9. West Street

11. Darnall

12. Chesterfield Road/Tesco

13. Chesterfield Road/Fashion Focus

15. Fitzwilliam Square (GPO)