UNIVERSITY OF LEEDS

Monograph:
Berrett, B., Leake, G., May, A.D. et al. (2 more authors) (1988) Economic Standards for Pedestrian Areas for Disabled People: Results from Observation Work. Working Paper. Institute of Transport Studies, University of Leeds , Leeds, UK.

Working Paper 255

Working Paper 255

October 1988

ERGONOMIC STANDARDS FOR PEDESTRIAN AREAS FOR DISABLED PEOPLE

Results from Observation Work

B Berrett
G Leake
A D May
T Parry
J Whelan

This work was sponsored by TRRL

C O N T E N T S

1. INTRODUCTION

1.1 Study Objectives and Structure

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

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

a) To produce a guide to good practice for the design and maintenance of footways and pedestrianised areas;

b) To provide, where possible, recommended standards for design and maintenance.

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

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

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

a) Contact and hold discussions with individuals and organisations involved or concerned with disabled people to identify priority issues for study;

b) Conduct a short initial interview survey with 10% of the registered disabled in Leeds in order to obtain a sample for each of the five selected disability types for further study. In addition control samples of 50 elderly and able-bodied respondents would also be selected;

c) Implement a physical survey of conditions in Leeds city centre to identify ranges of the individual impediments for further study;

d) Carry out more detailed interviews with a sample of 50 to 60 from each disability type in order to obtain perceptions and attitudes and to identify access-related barriers;

e) Conduct detailed observations of the ability of the members of the sample populations of the disability types and samples of the elderly and able bodied to tackle a series of identified impediments in Leeds city centre;

f) Conduct a brief follow-up interview with these same people to obtain their reactions to and perceptions of the on-site studies;

g) Analyse the results and develop relationships and resulting guidelines.

1.2 The Philosophy Adopted

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

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

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

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

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

1.2.6 Improving accessibility It is assumed that disabled people wish to use pedestrian facilities but that there can be barriers or impediments which prevent them from doing so. The project is concerned with providing advice on how to overcome these impediments. It focuses, therefore, on the accessibility of an area rather than its attractiveness. However, some of the reasons why disabled people use pedestrian areas were obtained during the detailed survey work.

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

1.3 Selection of Impediments for Study

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

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

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

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

1.4 Selection of Categories of Disablity for Study

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

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

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

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

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

2. METHOD

2.1 Pilot Work

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

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

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

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

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

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

Impediment	Characteristic Examined	Method
1. Movement Distance	Distance walked	Video and tape
	Time taken to walk	Video, tape, pen and paper
	Rest periods (if any)	Tape, video, pen and paper
	Problems	Tape, pen and paper
2. Surface Conditions	Gradients - observable aspects	Tape and video
	Gradients - assessment of problem	Tape, pen and paper
	Camber	as above
	Evenness	as above
3. Ramps	as surface conditions with the addition of:	
	Time taken to move	Video, tape, pen and paper
	Distance moved	Video, tape

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

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

Movement Distances Differences emerged between the groups regarding the time it took people to move over distances, as well as the distances people were willing/able to walk. The importance of selecting an appropriate route length and course was also clearly illustrated. It was also found necessary to devise techniques for keeping people within a group apart, during the exercise; e.g. by starting people at different times after indicating the route to be followed. It was essential to discuss each activity as soon as it had been completed, since neither the analysis of the video, nor that of tape or pen and

paper methods carried out during the activity adequately revealed if people were pushing themselves too much.

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

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

2.2 The Main Observation Work

The main observation period was planned to take place in September and October 1987. It was extended by two weeks in an attempt to obtain a wider range of weather conditions.

As recommended from the pilot, groups of 4 or 5 people were taken to Leeds City Centre at any one time and were accompanied by two interviewers and as St John's Ambulance Officer. The groups of people brought in had the same disability with broadly the same degree of severity. Initially two sessions were used; a morning one between 10.30 a.m. and 12.30 p.m., and an afternoon session from 1.00 p.m. to 3.00 p.m. Also, in the last three weeks of the survey period a further session was occasionally added by altering the timings to 9.30 - 11.30; 12.00 - 2.00; 2.30 - 4.30.

The participants were brought to a central point of Leeds, the fountain, by a private transport company specialising in transporting elderly and disabled people. This point was used as the start of the activities and provided a route to the refreshment centre over which the movement distance exercise was carried out. From the refreshment centre each group was taken along one of two routes in order to assess the surface conditions and ramps along the route. The route to be followed by each group was pre-selected in order to obtain a broadly equal split between the routes. However, there was a degree of flexibility

over this because of the capabilities of various people. Thus, some groups were taken on the shorter route because of problems being experienced by members of that group. Such deviations from the plan were noted and were balanced out by reorganising schedules during the observation work.

2.3 Movement Distance Exercise

The movement distance exercise was recorded on tape-recorder and video. The tape-recordist was required, prior to commencing the activity, to read into the tape recorder details of each person taking part; the date, time and weather and any other general comments. At this stage the pulse-rate of each volunteer was taken by the St John's attendant and noted. A short pen and paper interview was also held with each volunteer to ascertain some background details. This included the mobility aids being used;their functional capabilities; style of movement; and type of footwear.

On commencing the activity itself the time at which each person set-off was recorded, as was the time at which they passed certain landmarks. The landmark was also read into the tape recorder. Any pauses or rests were also timed, as were any details of problems encountered along the route. Likewise the video recordist followed the movement of all the group, as far as reasonably possible, from start to finish. On some days of the exercise it was not possible to obtain a video recording.

At the end of the movement distance activity refreshments were provided. The pulse rate of each individual was again taken by the St John attendant, as were details of any medications in order to assess the effect upon the pulse and activity in general. A short interview was also carried out with each person to see how unusual the demands of the activity had been upon them, and to obtain their views of the route covered. Essential questions were asked, such as whether the distance travelled had been excessive; if the time spent walking had been unusual; if the route was familiar; and if there had been any unusual demands placed upon them by the activity.

2.4 Surface Conditions/Ramps/Public Transport Areas

After the refreshment period each group was taken along a particular route in a specified direction, and filmed along the entire route. The groups were stopped at regular intervals of approximately 30 metres or when a particular design feature had been traversed. At this point they were asked a series of questions relating to the area they had just moved across.

Essentially, there were eight aspects covered, namely:-

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

The time taken to move over the route section was also recorded.

A five-point semantic-differential scale was used to record responses, namely:-

Impossible	Very Difficult	Difficult	Some Difficulty	No Difficulty
[ ]	[ ]	[ ]	[ ]	[ ]

The use of the 'Impossible' term was introduced to assess whether excessive demands were being placed upon the individual. It was expected that a range of responses would be obtained using this device given the results of the pilot survey, and that this would allow an assessment of the various design ranges to be obtained.

At regular intervals during the exercise the pulse-rate was recorded for each individual, and their well-being monitored by the St John attendant. This allowed early recognition to be made in two instances of excessive demands being placed upon certain individuals. In both these situations contingency plans were operated. In the one case this meant the use of the mobile seating that was on-hand, and in the other it meant taking the person back to the pick-up point before they had travelled to the more remote parts of the route.

An attempt was made to measure objectively each of the route section characteristics by the methods outlined below. Tables indicating the values given to route section characteristics are set out in the Appendices.

2.5 Site Measurement

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

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

2.5.3 Gaps A gap was defined as having a minimum width of 20 mm and depth of 5 mm. In practice an element of judgement was required to interpret the definition, as can be seen from Fig 2.1, where the gaps do not totally fulfil the requirements. To find the gaps to be recorded a length of cotton was laid out and tightened following the route taken by participants. A close examination of the ground immediately under the line of the cotton was made, and where a gap was found it was categorised and recorded. The number of gaps of 20-30 mm, 30-40 mm and greater than 40 mm were recorded, as was the direction of the gap.

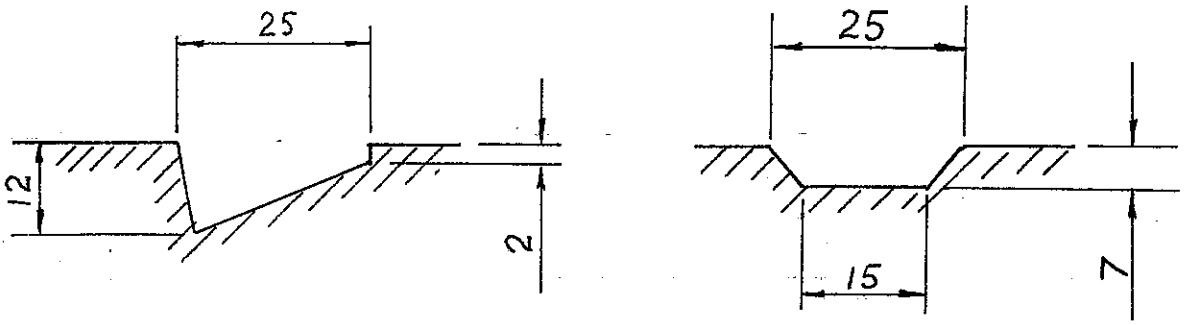


Figure 2.1

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

i) A length of cotton was laid out and tightened over the route followed by participants. A close examination of the ground immediately under the cotton was made and notes made of all height displacements of greater than 5mm. Kerbs were not included. The displacement was categorised into 5-10 mm, 10-15 mm, 15-20 mm, 20-25 mm and > 25 mm groups.

Judgement was sometimes needed to decide into which category a height displacement would fall, or whether to include a discontinuity as a height displacement, as Figure 2.2 illustrates.

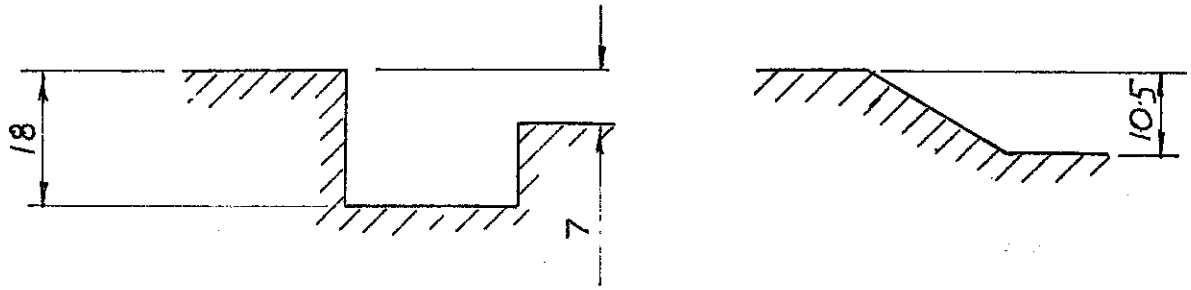


Figure 2.2

ii) The second method took a completely different approach, and did not concentrate on measurements of lips which could cause respondents to trip, but compared small samples of the route sections to an hypothetical plane fitted to match the slope of the sampled sites.

A rectangular grid 5m x 2m with nodes at 0.5m intervals was laid out over specimen areas in chalk in the direction in which the participants travelled. The specimen areas were those judged by eye to be the most uneven areas to be found on parts of the route section over which participants typically moved. Two grids were laid out for each section of route.

Using a laser levelling device the variation of each of the nodes from a hypothetical horizontal plane was found. With the aid of a computer program the hypothetical plane was generated which provided the best fit to the grid data using the method of least squares. The mean absolute deviation of the nodes from the fitted plan was then found and used as a measure of height displacement.

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

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

3. RESULTS

3.1 Background

The Figures that follow give the results of the observation exercise. Each set of results is prefaced by a few remarks. Route sections for which an assessment was given by less than eleven participants of any disability category have been excluded from the presentation of results for that category.

Along the (horizontal) x-axis of each figure is given the following information:

1. The identity of each route section used in the Figure. For example, in the slope assessment by wheelchair users, Fig 3.36, the following sites were used B, F, M, I, C, N, H, K, D, L, A, G, E, J. The location of route sections is shown in Appendix C.

2. The characteristic being measured. For example, in the slope assessment by wheelchair users, Fig 3.36, "gradient at steepest part of route section (%)".

3. The values obtained for the route section characteristics. For example, in the slope assessment by wheelchair users, the gradients found along the route ranged from - 8% to + 9%, with the gradient of route section E being +7%.

Along the (vertical) y-axis is given the percentage of participants saying that they had different levels of difficulty.

In presenting the results, the possible answers have been combined to show:

(a) Participants expressing at least some difficulty (termed the first level of difficulty).

(b) Participants stating that they found the route section characteristics very difficult or impossible (termed the second level of difficulty).

The □ symbol represents those participants who said that they had at least some difficulty (i.e. those specifying: some difficulty, difficulty, very difficult, impossible - the first level of difficulty.

The ◊ symbol represents those participants who said that they found the route section either very difficult or impossible to deal with - the second level of difficulty.

For example, in the slope assessment by wheelchair users, Fig 3.36, at site M where there was a gradient of - 1.7%, 40% of respondents said that they had, at least, some difficulty (represented by the □), and 5% of respondents said that they found the route section very difficult or impossible to deal with (represented by the ◊).

3.2 Assessment of Grip A high skid resistance value indicates a high level of skid resisitance. No relationship is apparent between the measured skid resistance and the assessed difficulty for the visually handicapped group. For the other groups it is apparent that, despite the substantial scatter shown in these figures, there is less first or second level difficulty reported when the surfaces have low skid resistance than when they have high skid resistance.

A possible explanation for the results is that people with ambulatory difficulties tend to drag their feet, and hence the higher frictional values are a disadvantage.

The greatest first level difficulty is found with the wheelchair users, Fig 3.1, and the ambulatory (severe) group, Fig 3.5, and the least difficulty is reported by the elderly and able-bodied groups, Fig 3.6 and 3.7.

The route sections with the least skid resistance were those where the principal surface was yellow brick paving (E, F, I). In these route sections the other characteristics were generally good, and it is possible that these other characteristics may have influenced the opinions expressed by participants.

Fig 3.1

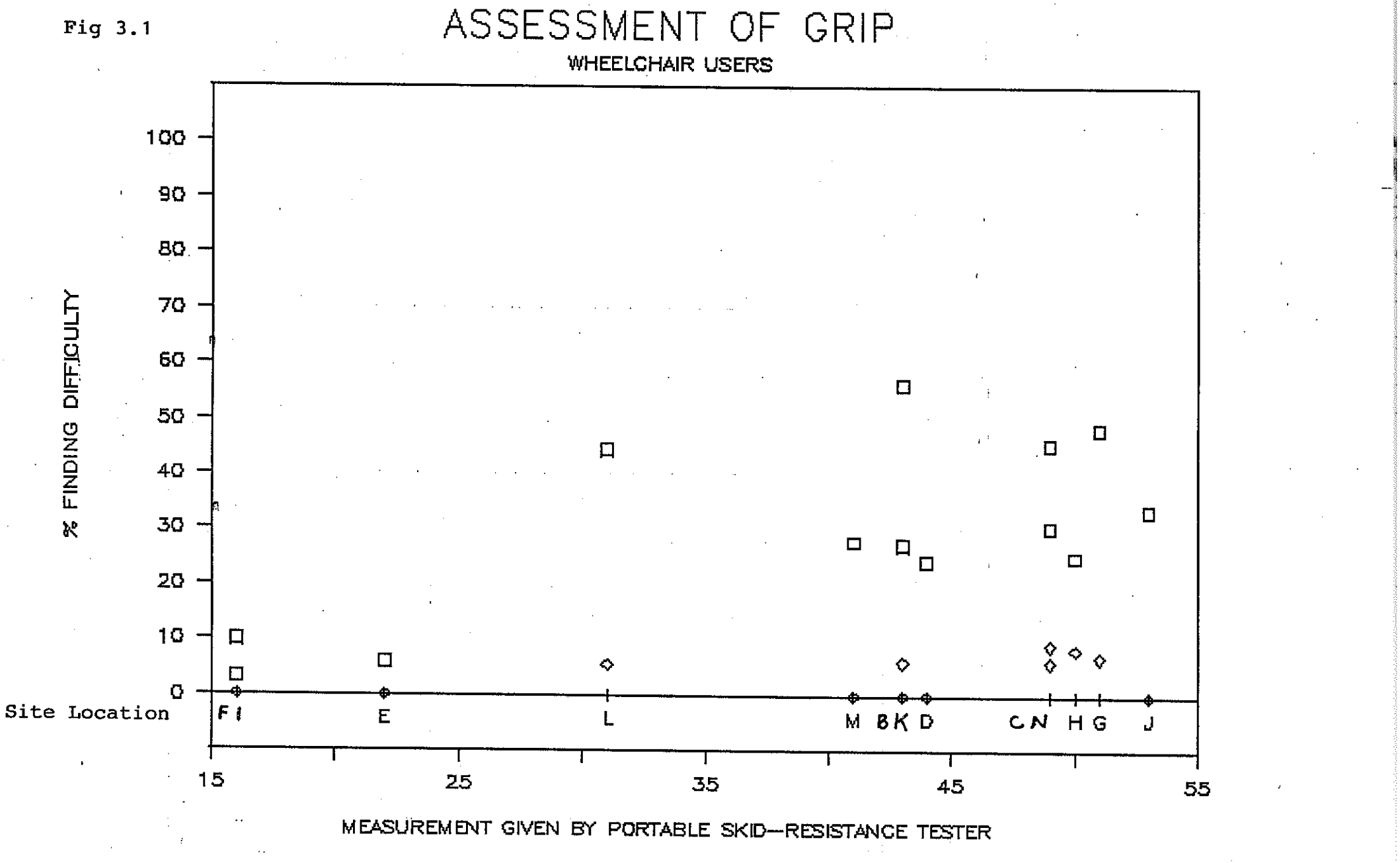

ASSESSMENT OF GRIP
WHEELCHAIR USERS
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
F I
E
L
M
B K
D
C N
H
G
J
15
25
35
45
55
MEASUREMENT GIVEN BY PORTABLE SKID—RESISTANCE TESTER
At least some difficulty
Very difficult or impossible

Fig 3.2

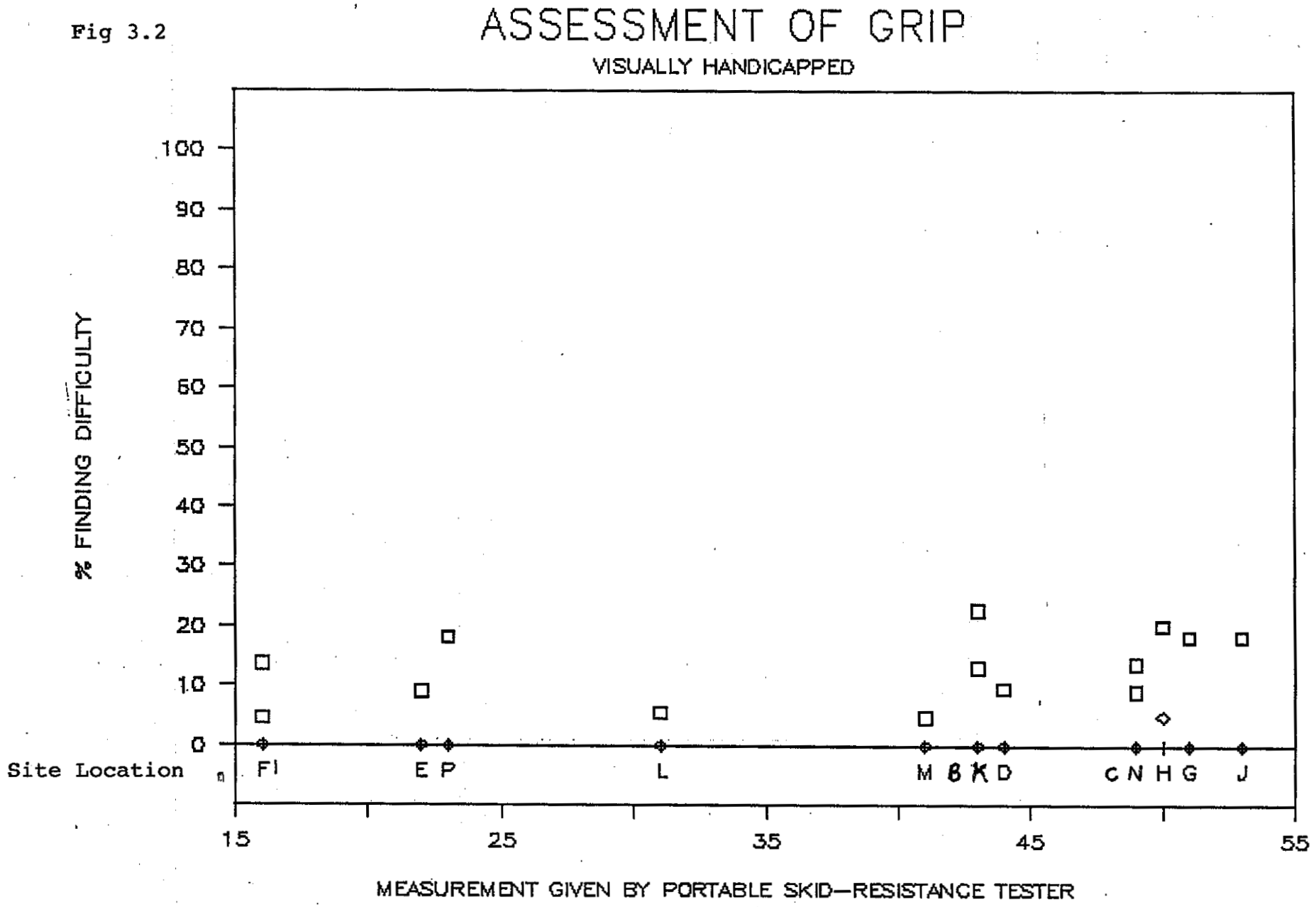

ASSESSMENT OF GRIP
VISUALLY HANDICAPPED
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
Fl
E P
L
M B K D
C N H G J
15
25
35
45
55
MEASUREMENT GIVEN BY PORTABLE SKID—RESISTANCE TESTER
At least some difficulty
Very difficult or impossible

Fig 3.3

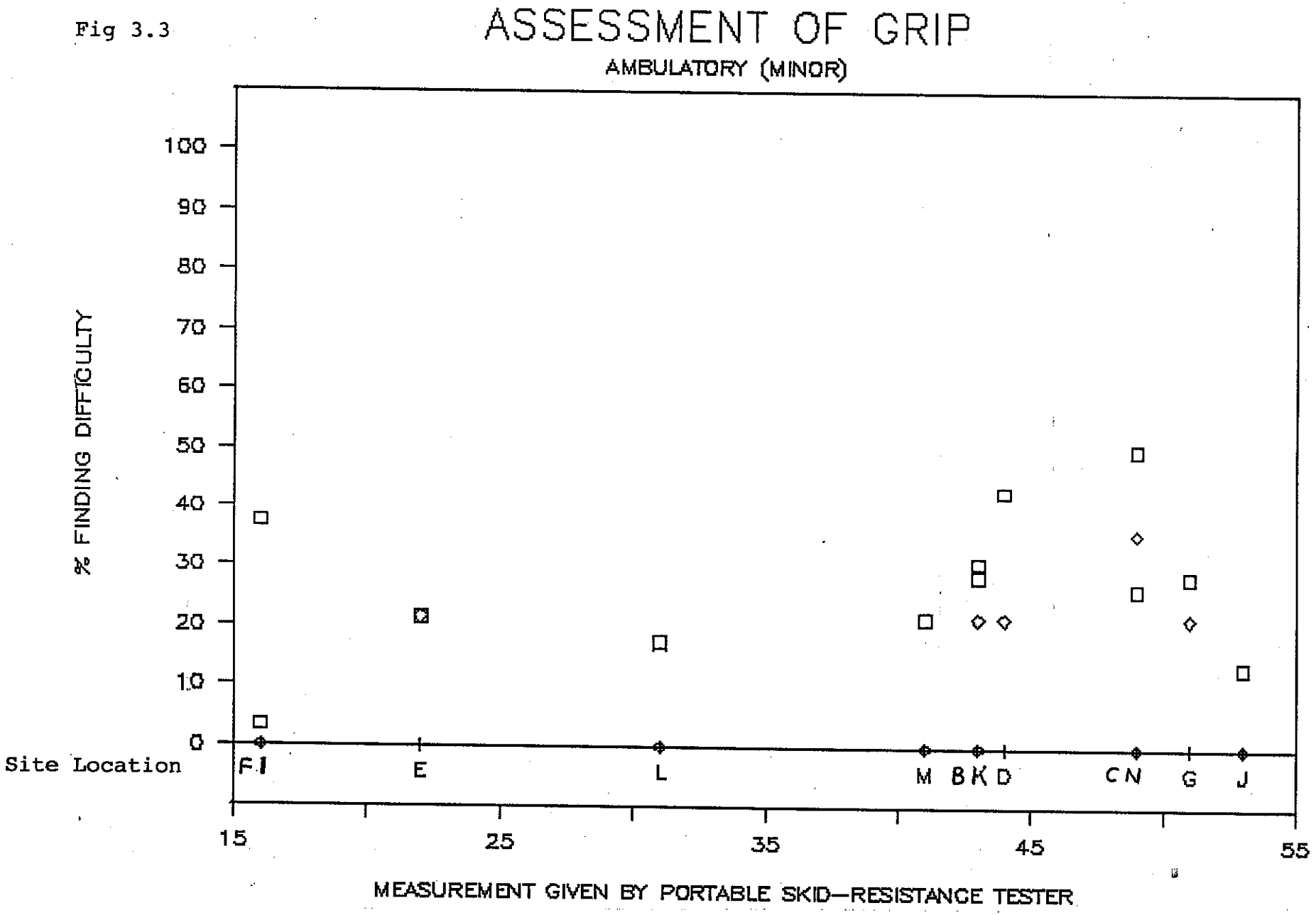

ASSESSMENT OF GRIP
AMBULATORY (MINOR)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
F I
E
L
M
B
K
D
C N
G
J
15
25
35
45
55
MEASUREMENT GIVEN BY PORTABLE SKID—RESISTANCE TESTER
At least some difficulty
Very difficult or impossible

Fig 3.4

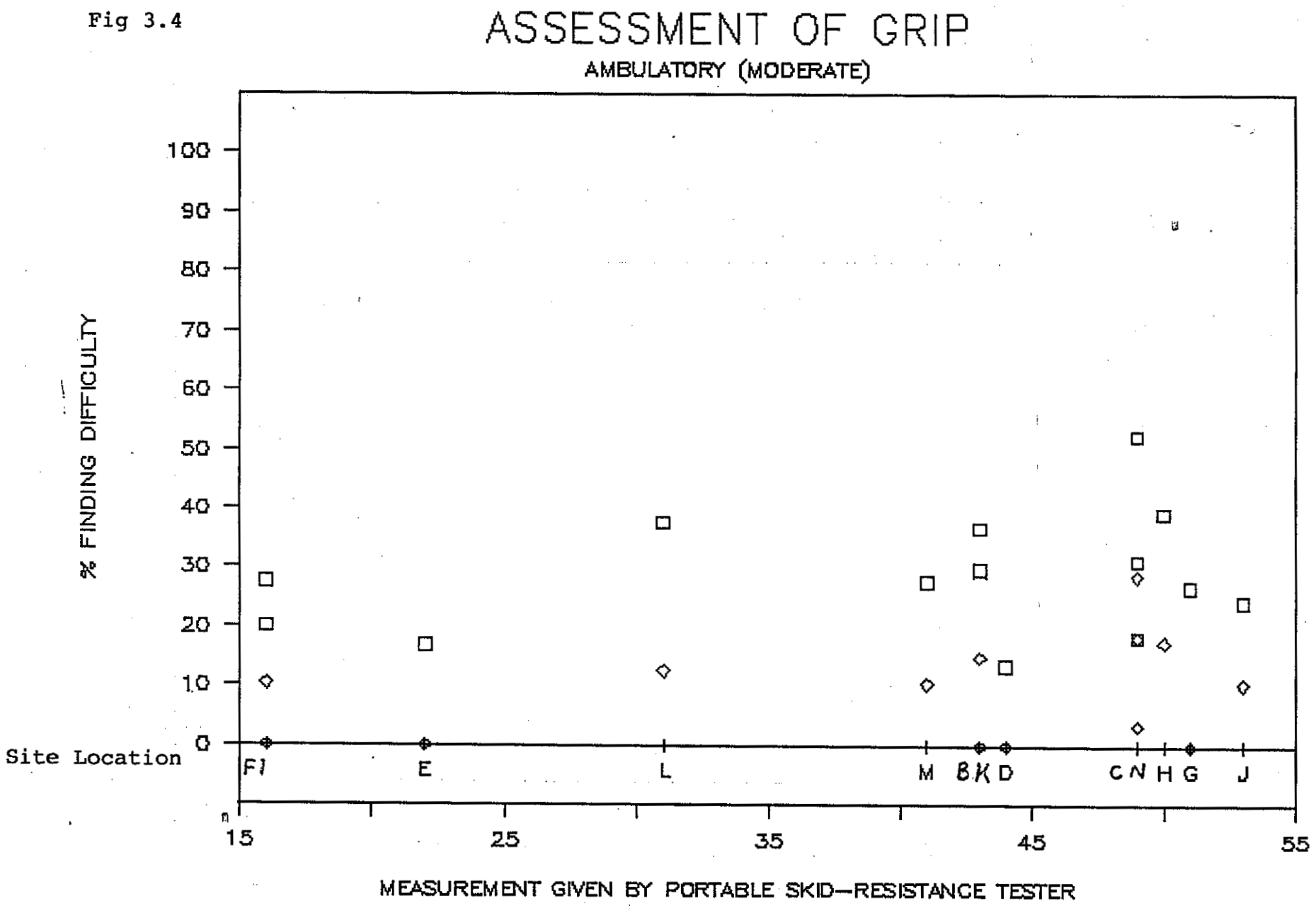

ASSESSMENT OF GRIP
AMBULATORY (MODERATE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
F I
E
L
M
B K
D
C N
H
G
J
15
25
35
45
55
MEASUREMENT GIVEN BY PORTABLE SKID—RESISTANCE TESTER
At least some difficulty
Very difficult or impossible

Fig 3.5

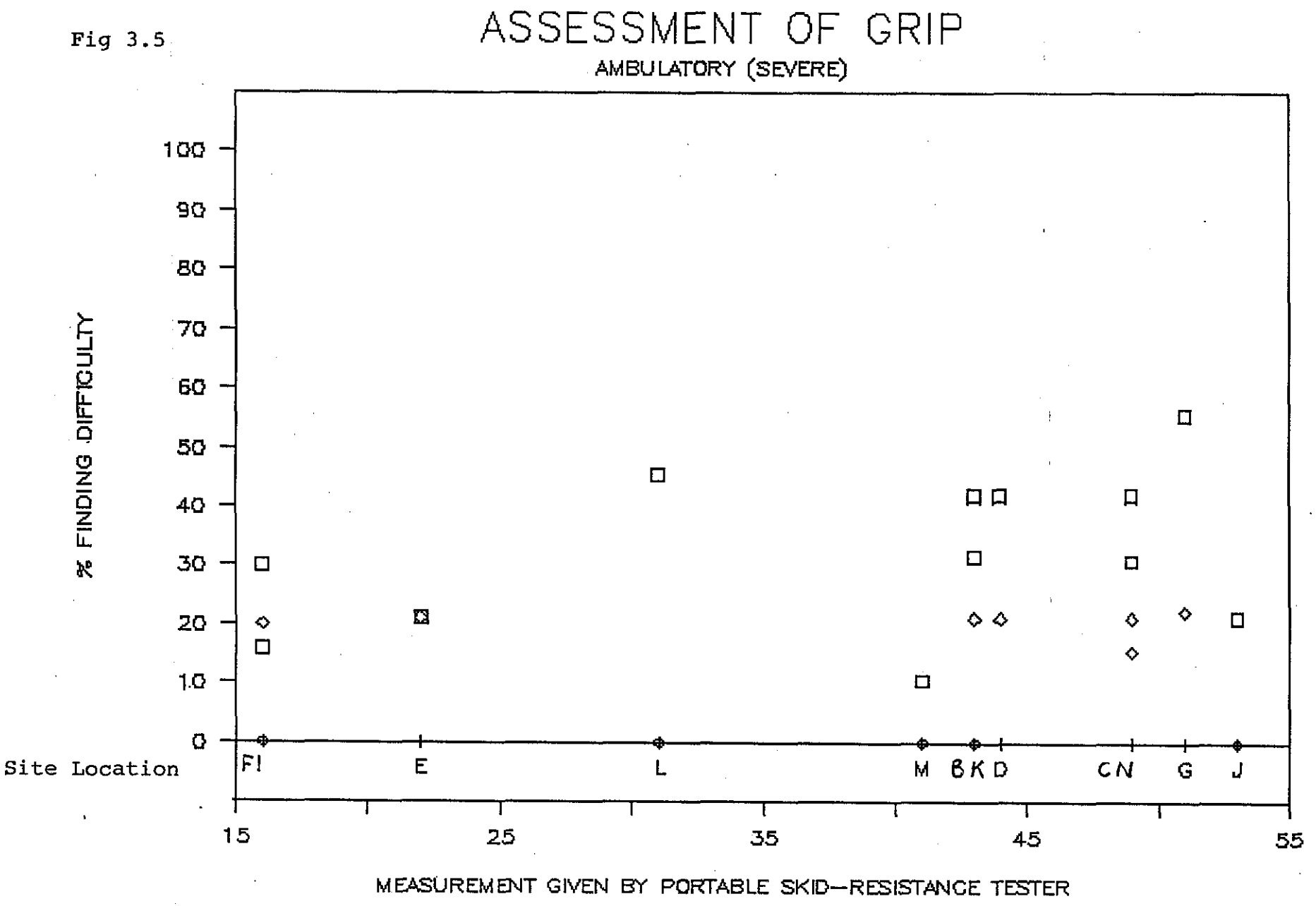

ASSESSMENT OF GRIP
AMBULATORY (SEVERE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
F
I
E
L
M
B
K
D
C
N
G
J
15
25
35
45
55
MEASUREMENT GIVEN BY PORTABLE SKID—RESISTANCE TESTER
At least some difficulty
Very difficult or impossible

Fig 3.6

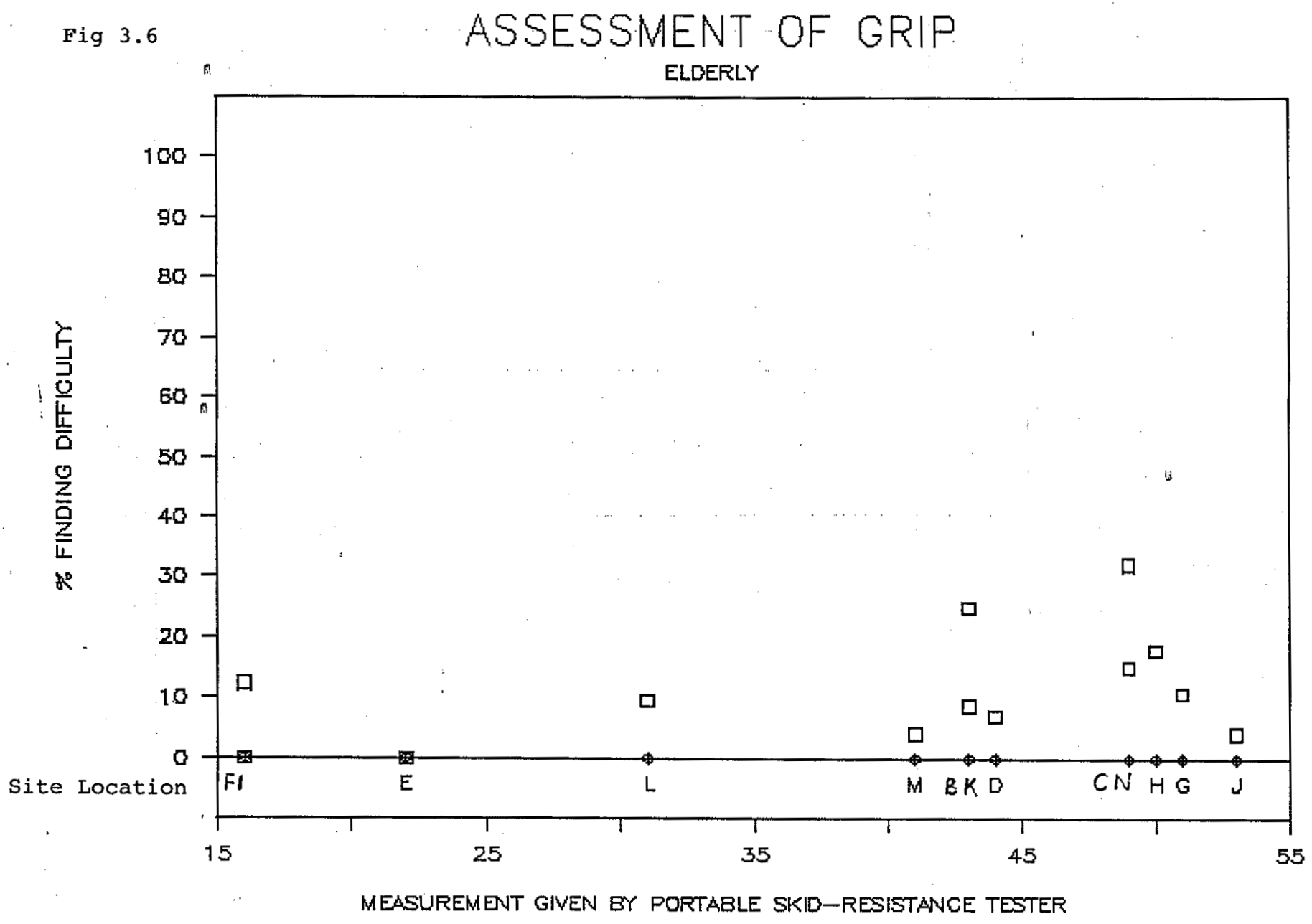
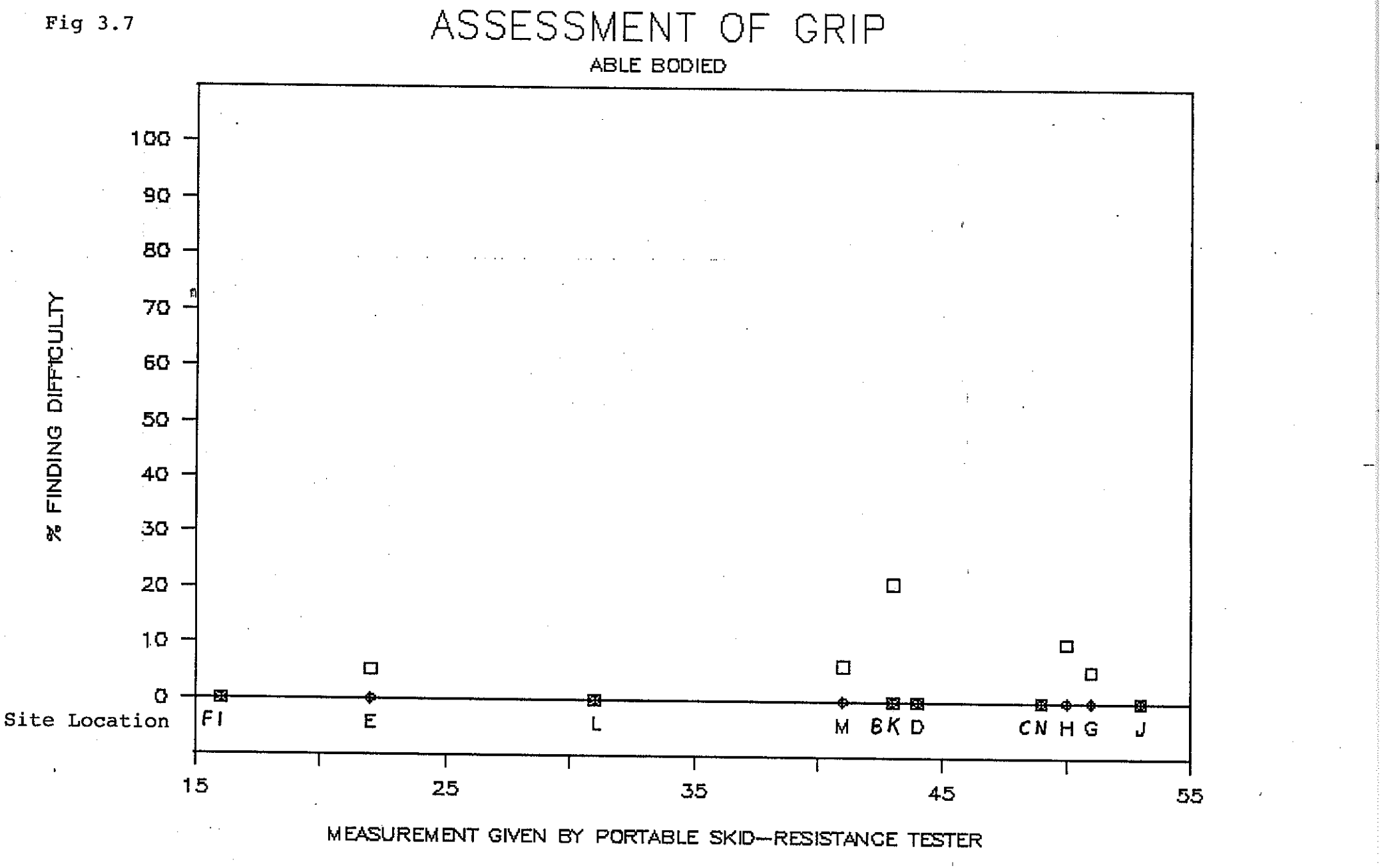

ASSESSMENT OF GRIP
ELDERLY
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
Fl
E
L
M
B
K
D
C
N
H
G
J
15
25
35
45
55
MEASUREMENT GIVEN BY PORTABLE SKID—RESISTANCE TESTER
At least some difficulty
Very difficult or impossible

Fig 3.7


ASSESSMENT OF GRIP
ABLE BODIED
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
F I
E
L
M
B K
D
C N
H
G
J
15
25
35
45
55
MEASUREMENT GIVEN BY PORTABLE SKID—RESISTANCE TESTER
At least some difficulty
Very difficult or impossible

3.3 Assessment of Gaps Between Pavers

There is no strong relationship between the percentage finding difficulty at the first or second levels of difficulty and the measured frequency of gaps in individual route sections except that there is generally a difference in reported difficulty between those route sections with no gaps, and those route sections with gaps.

It is possible that the minimum gap dimension of 20 mm width is too large and this may have given a misleading result.

It is clear that gaps in the pavers do cause considerable difficulties for all the disability groups, and for wheelchair users in particular. The able bodied group, who recorded very low levels of difficulty for other route section characteristics, recorded over 90% finding difficulty with one particular route section, and a substantial percentage found difficulty at other route sections so it is apparent that gaps between pavers are the principal characteristic causing difficulty for the able bodied.

Fig 3.8

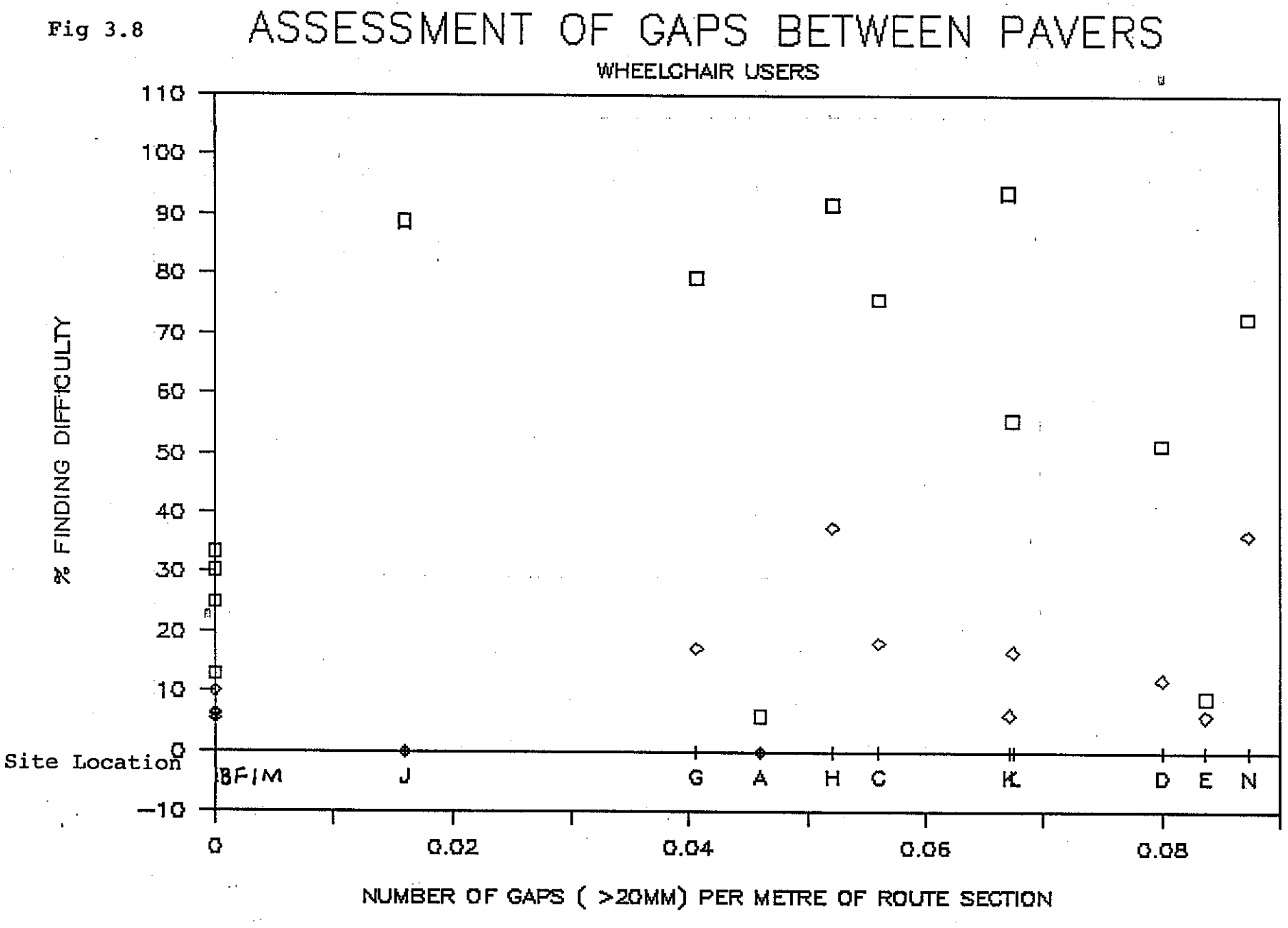

ASSESSMENT OF GAPS BETWEEN PAVERS
WHEELCHAIR USERS
% FINDING DIFFICULTY
110
100
90
80
70
60
50
40
30
20
10
0
-10
Site Location
BF/M
J
G
A
H
C
K
D
E
N
0
0.02
0.04
0.06
0.08
NUMBER OF GAPS (>20MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.9

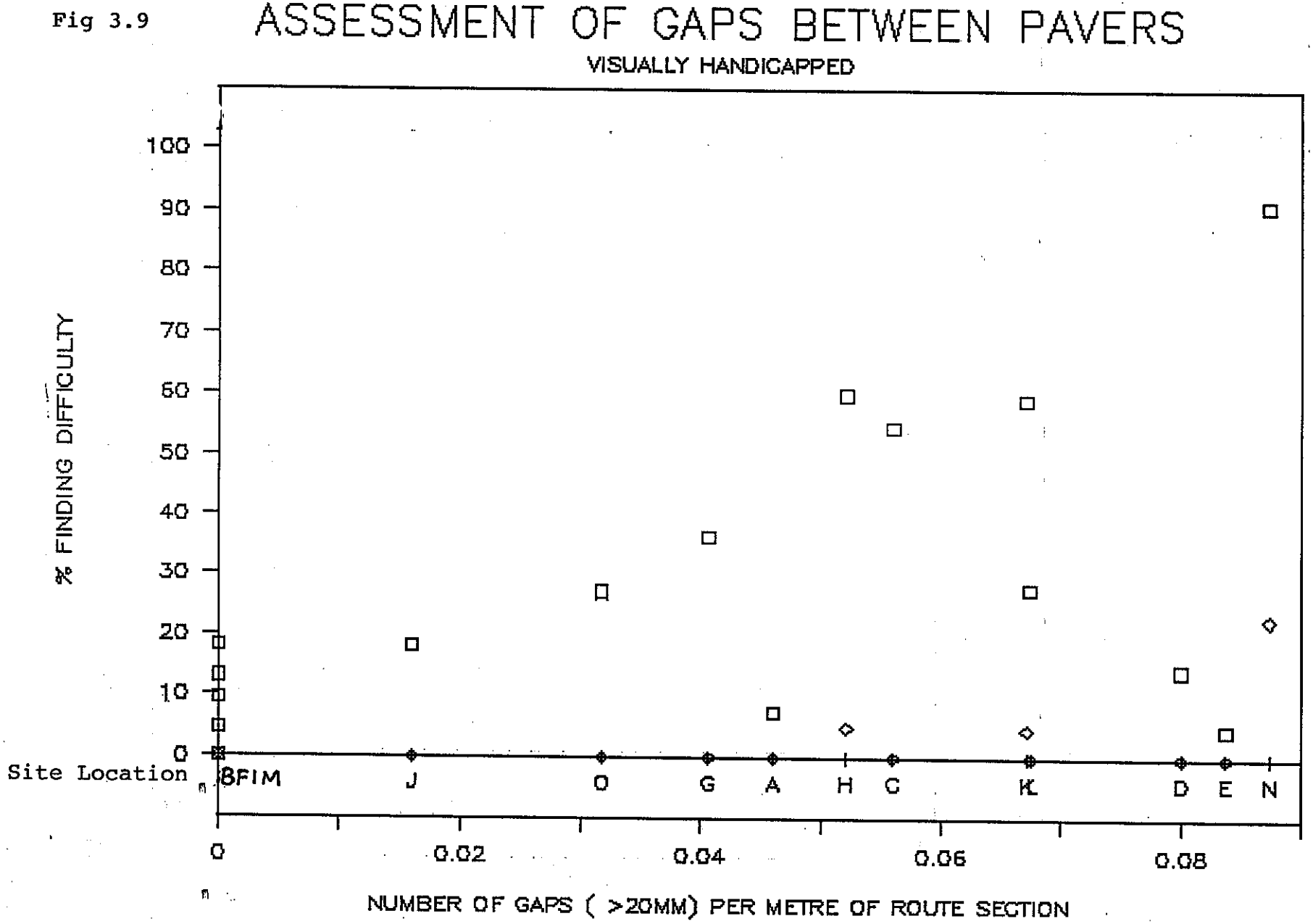

ASSESSMENT OF GAPS BETWEEN PAVERS
VISUALLY HANDICAPPED
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
BFIM
J
O
G
A
H
C
K
D
E
N
0
0.02
0.04
0.06
0.08
NUMBER OF GAPS (>20MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.10

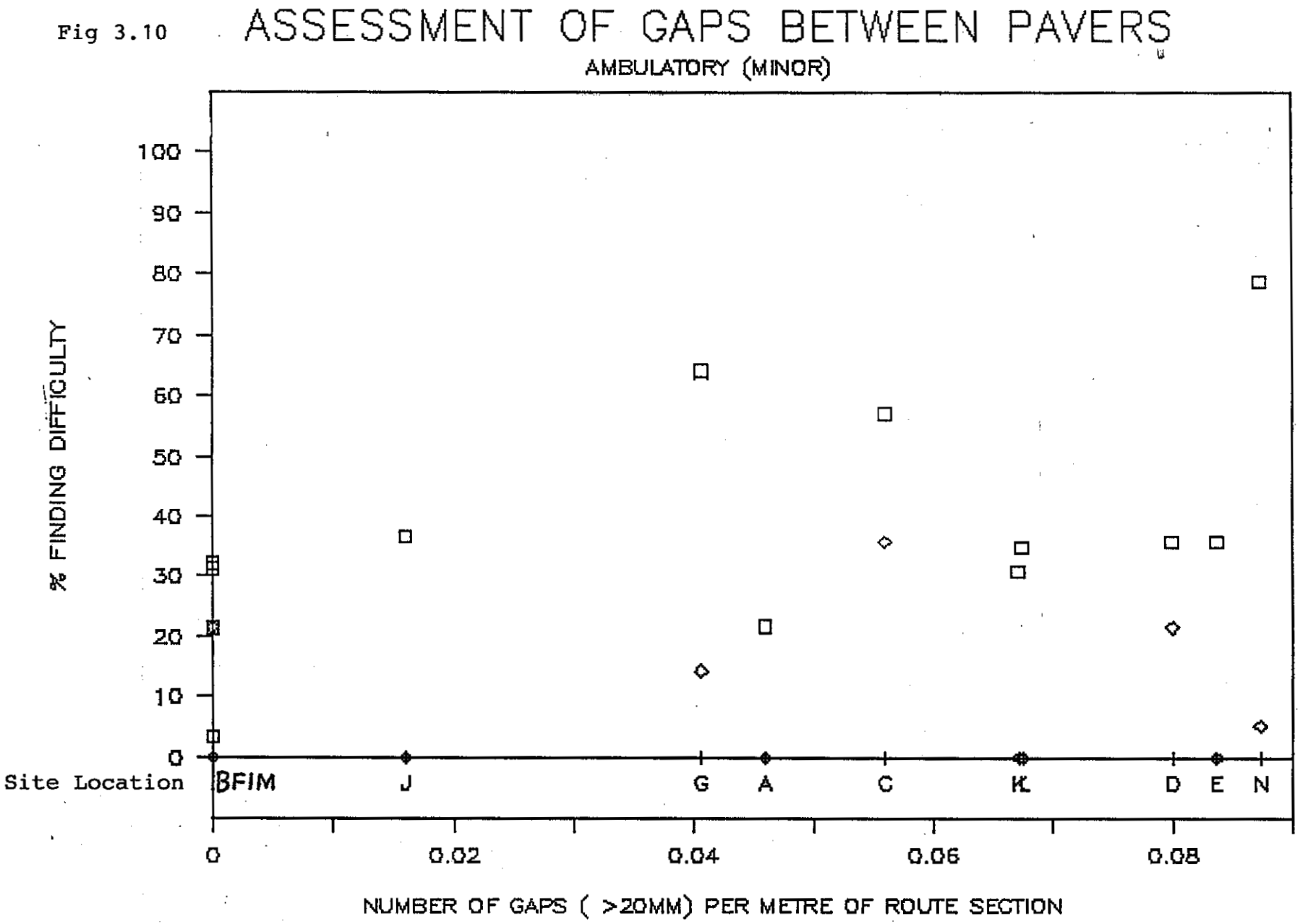

ASSESSMENT OF GAPS BETWEEN PAVERS
AMBULATORY (MINOR)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
BFIM
J
G
A
C
K
D
E
N
0
0.02
0.04
0.06
0.08
NUMBER OF GAPS (>20MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.11

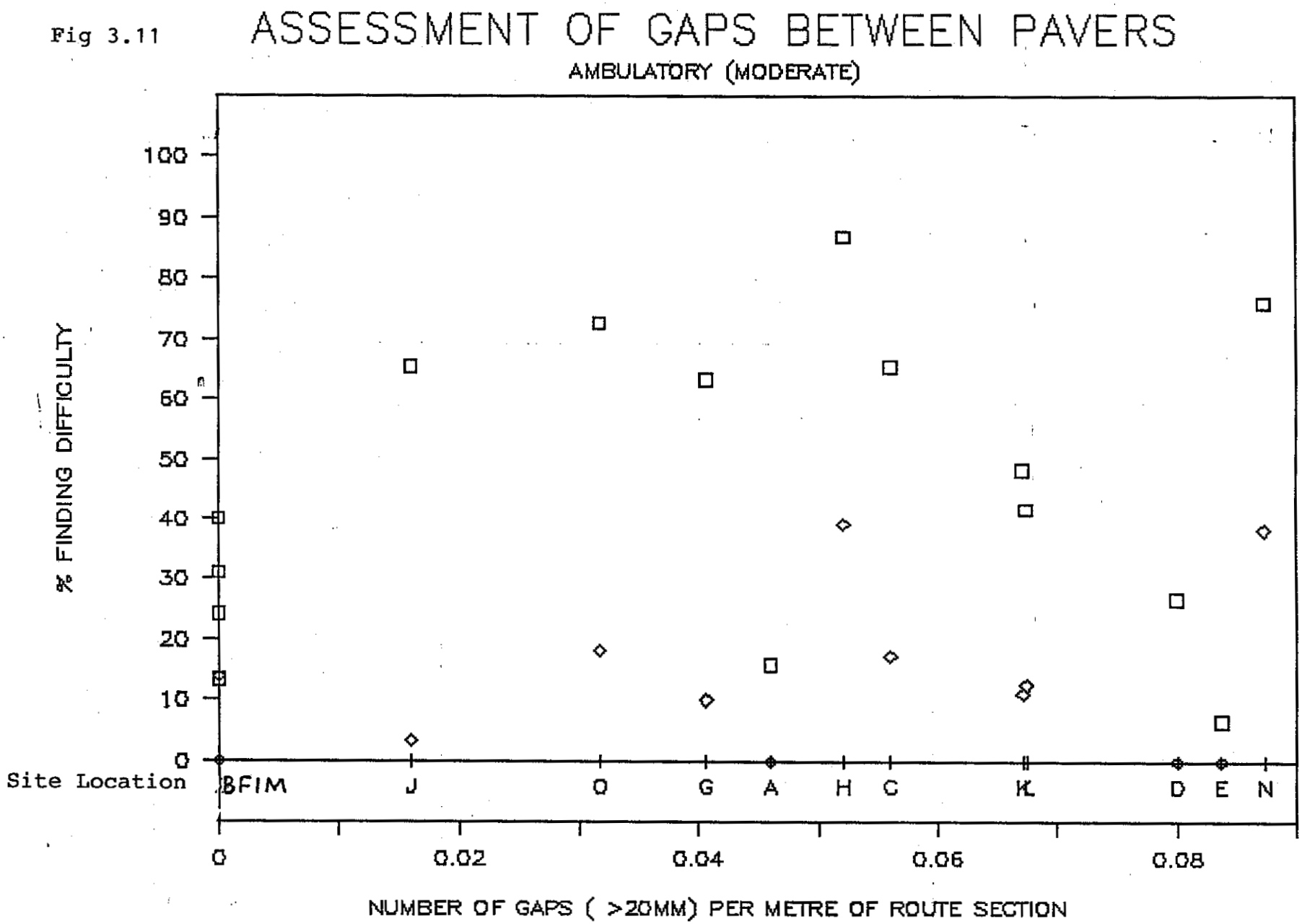

ASSESSMENT OF GAPS BETWEEN PAVERS
AMBULATORY (MODERATE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
BFIM
J
O
G
A
H
C
K
D
E
N
0
0.02
0.04
0.06
0.08
NUMBER OF GAPS (>20MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.12

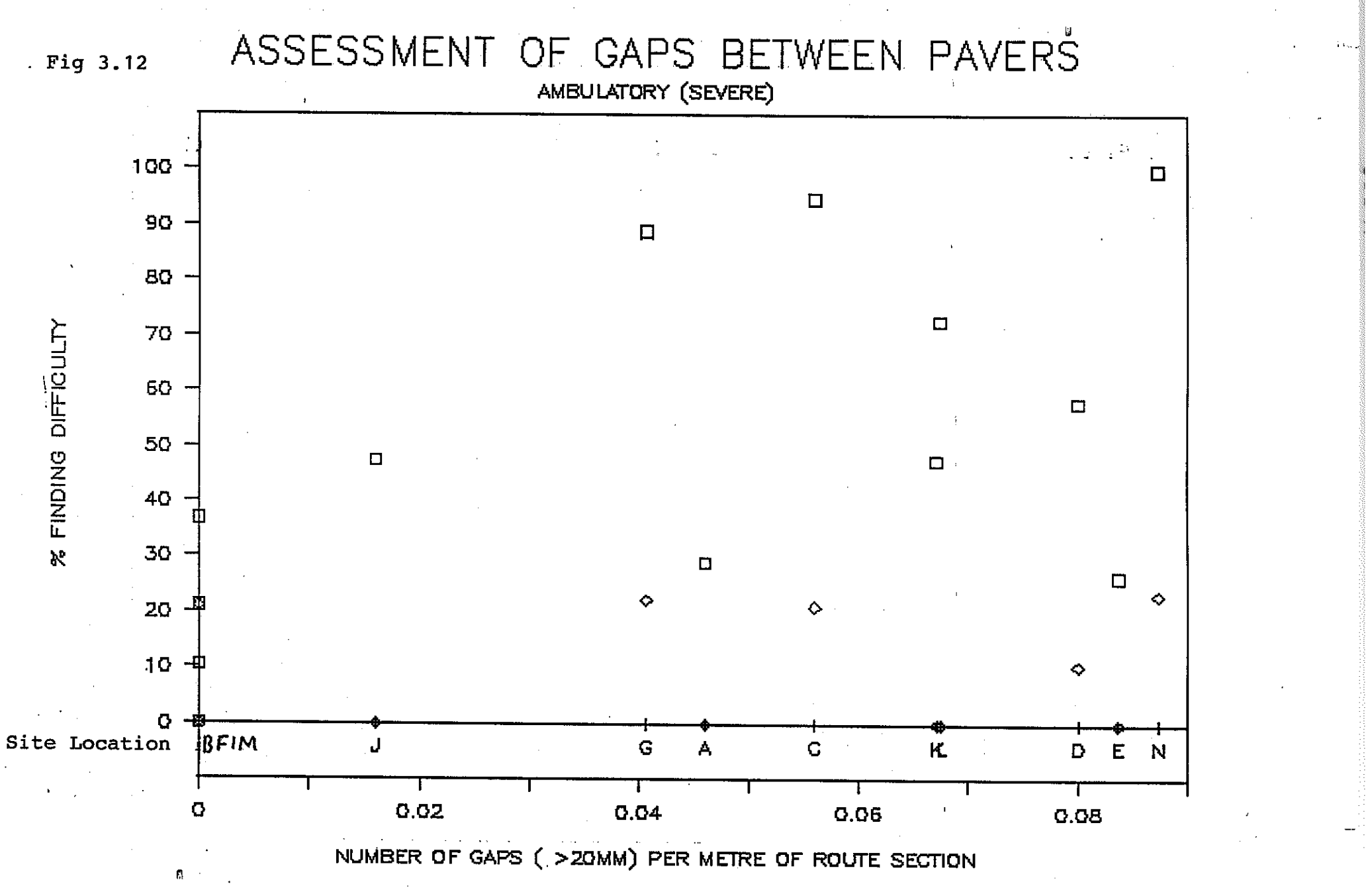

ASSESSMENT OF GAPS BETWEEN PAVERS
AMBULATORY (SEVERE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
BFIM
J
G
A
C
K
D
E
N
0
0.02
0.04
0.06
0.08
NUMBER OF GAPS (>20MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.13

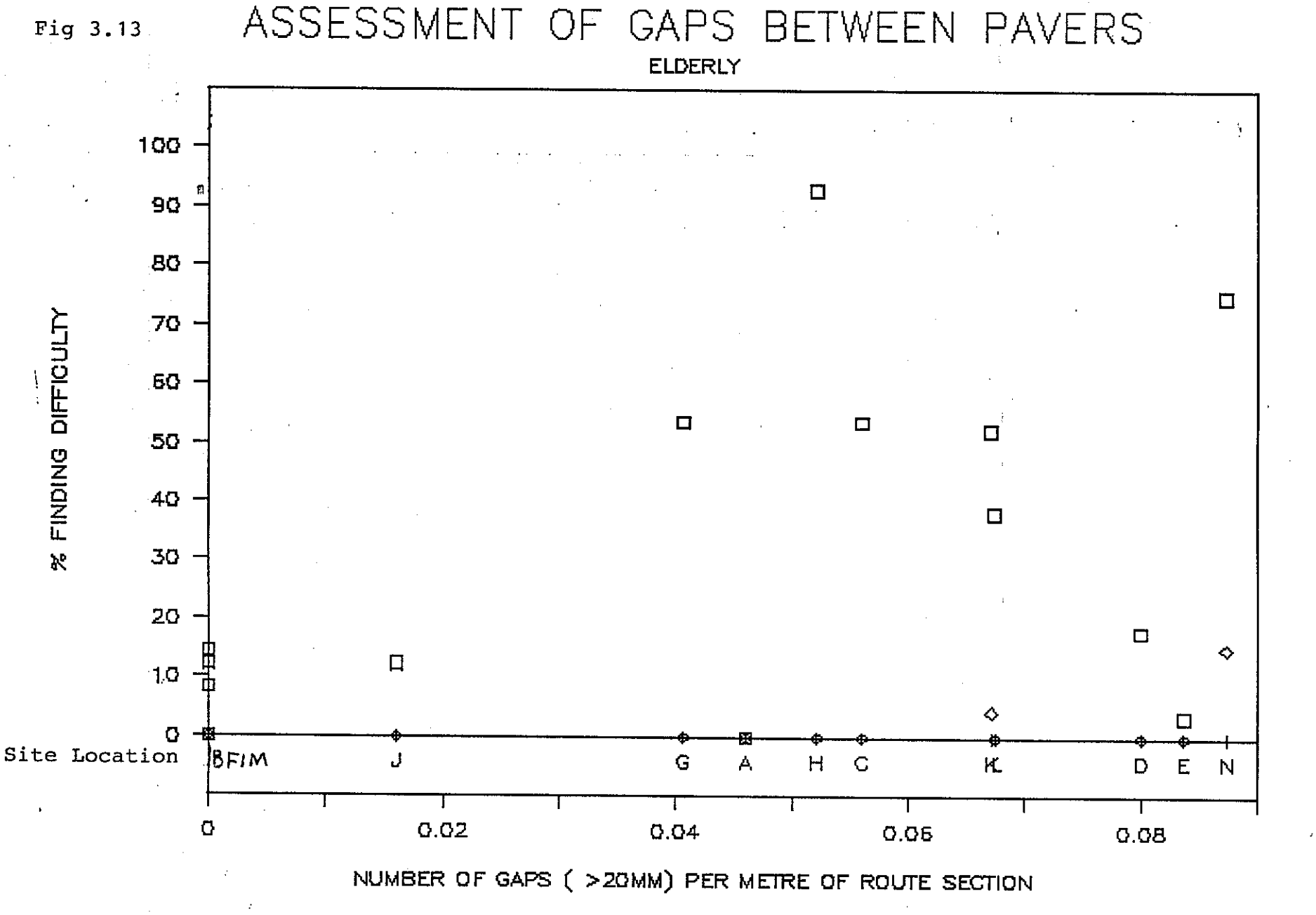
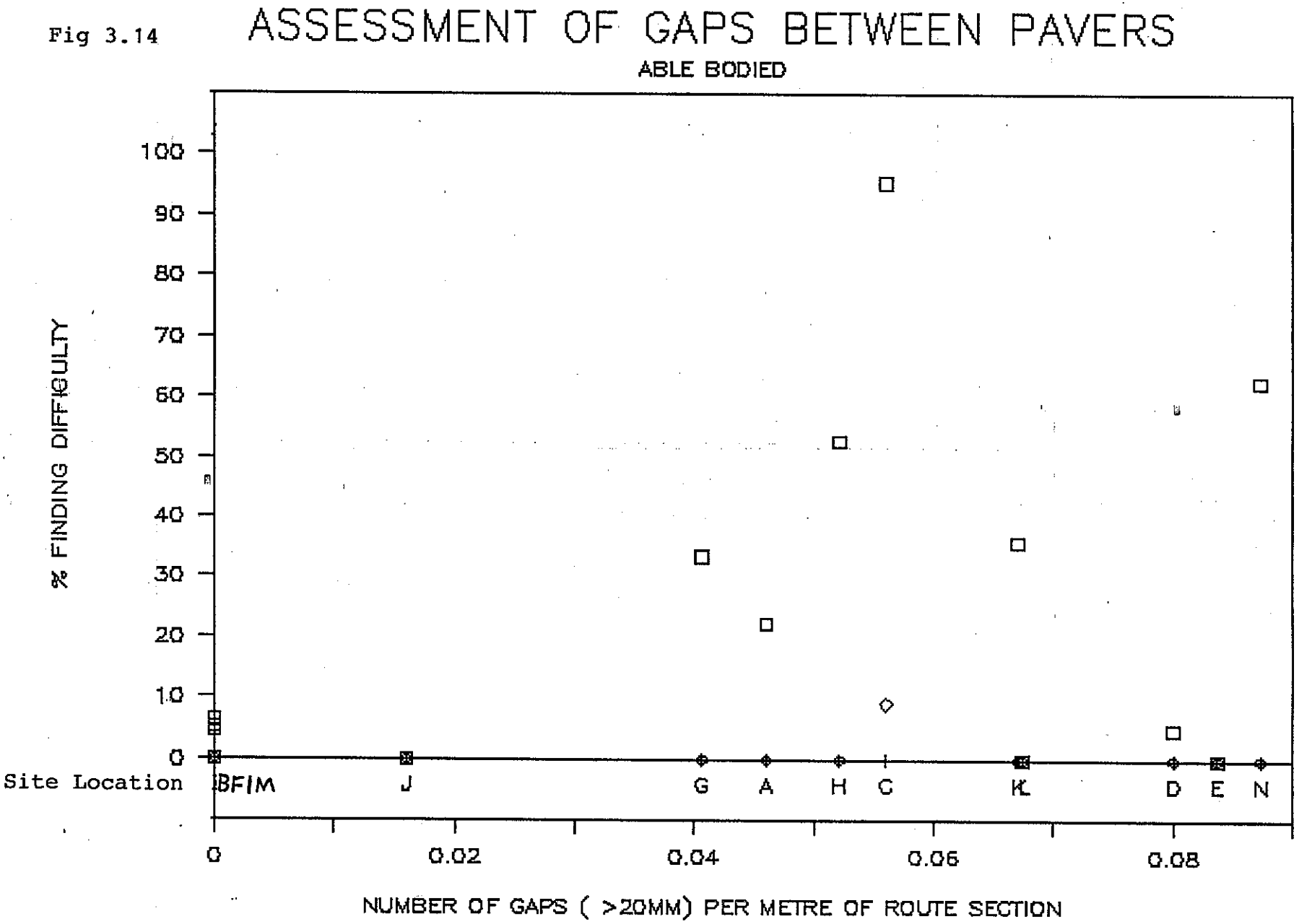

ASSESSMENT OF GAPS BETWEEN PAVERS
ELDERLY
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
BFIM
J
G
A
H
C
K
D
E
N
0
0.02
0.04
0.06
0.08
NUMBER OF GAPS (>20MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.14


ASSESSMENT OF GAPS BETWEEN PAVERS
ABLE BODIED
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
BFIM
J
G
A
H
C
K
D
E
N
0
0.02
0.04
0.06
0.08
NUMBER OF GAPS (>20MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

3.4 Assessment of Height Differences Between Pavers

As described earlier, two methods have been employed to attempt to measure the height differences between pavers over the route sections.

In the first, given in Figs 3.15 - 3.21, the frequency with which lips that could cause tripping is measured, and in the second, given in Figs 3.22 - 3.28, a measure of "undulation" is obtained by comparison to a hypothetical plane.

The first method yields no relationship with the assessment made by participants.

In the second, however, some relationship is apparent at the first level of difficulty between the mean absolute variation from the hypothetical plane and wheelchair users, visually handicapped and ambulatory (severe) group, Figs 3.22, 3.23 and 3.26 respectively.

As with gap, there is a difference between the type of paving: A, E, F, I are principally composed of yellow brick paving, having a low level of undulation, and generally receiving low assessments of difficulty, whereas other paving types are associated with higher levels of difficulty.

Fig 3.15

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS

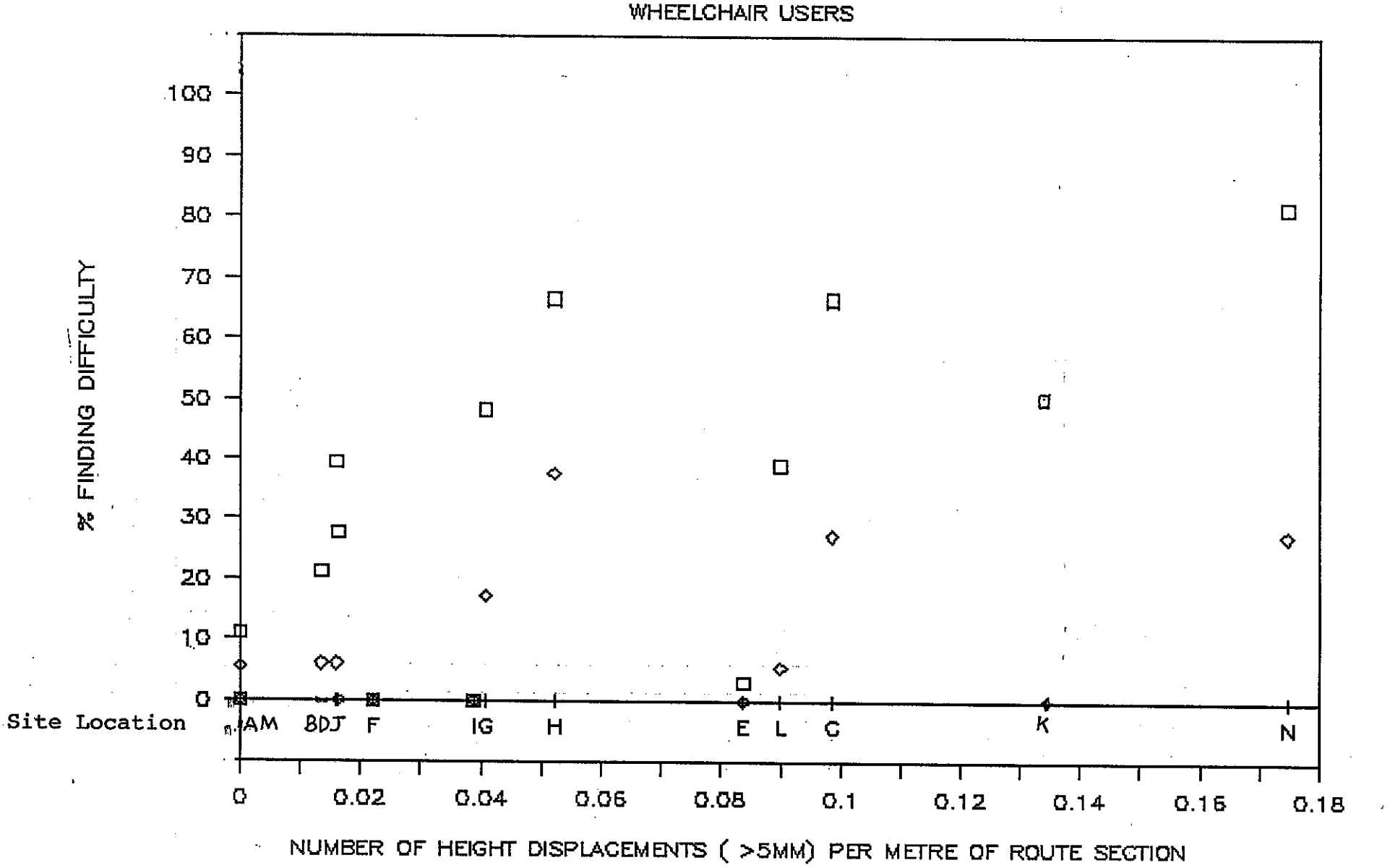
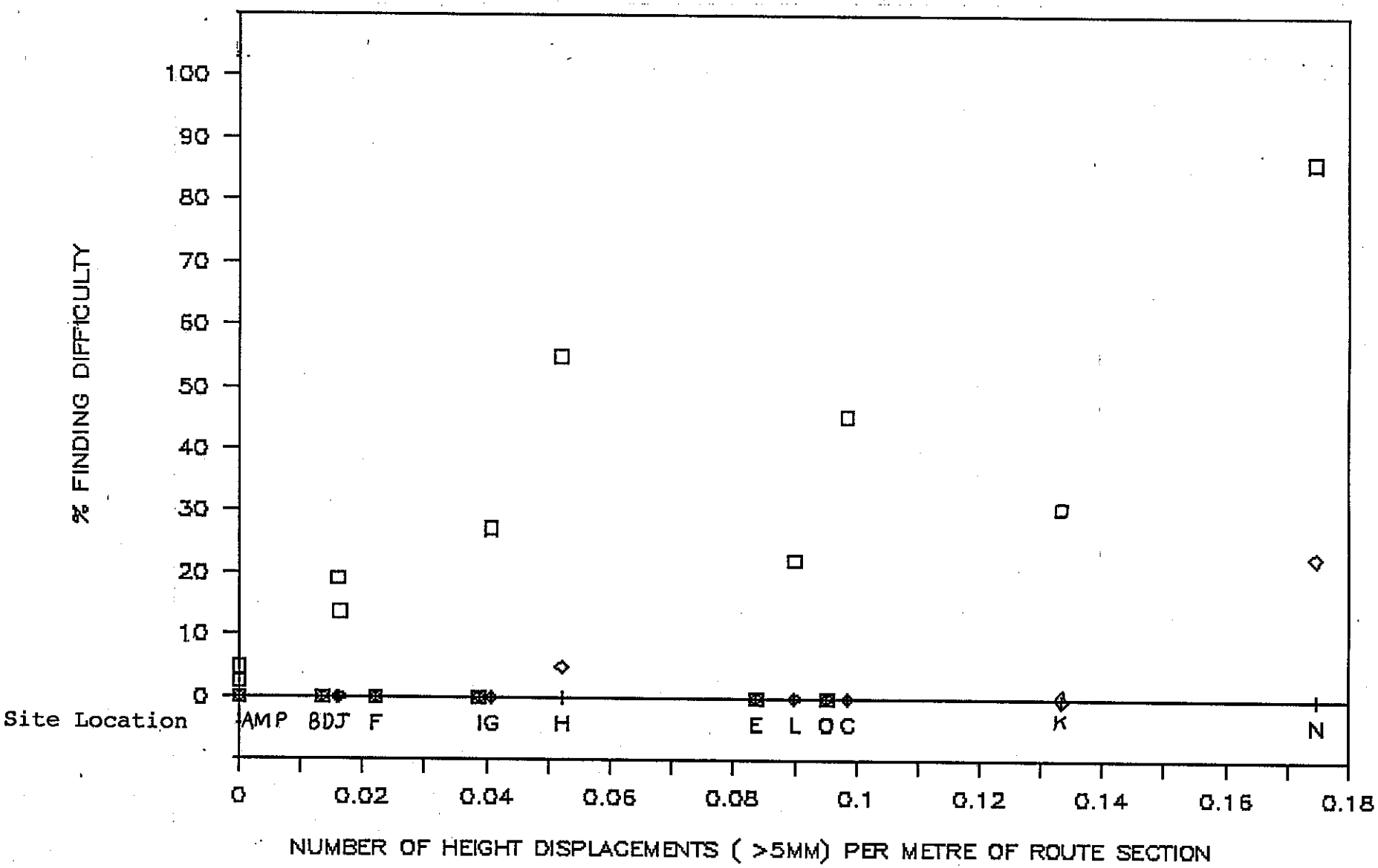


Fig 3.16

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS

VISUALLY HANDICAPPED



□ At least some difficulty

◇ Very difficult or impossible

Fig 3.17

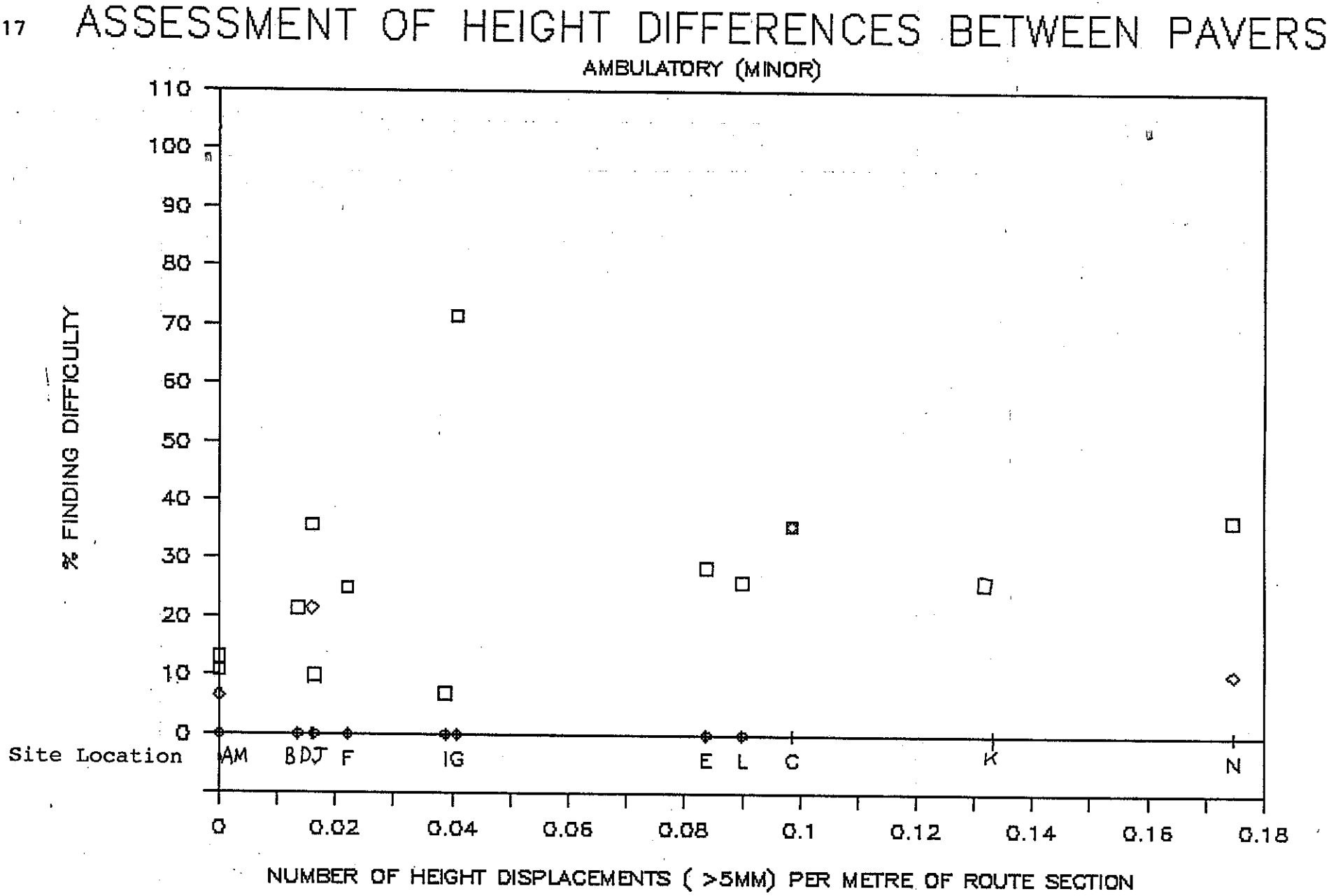

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS
AMBULATORY (MINOR)
% FINDING DIFFICULTY
110
100
90
80
70
60
50
40
30
20
10
0
Site Location
AM
B DJ
F
IG
E
L
C
K
N
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
NUMBER OF HEIGHT DISPLACEMENTS (>5MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.18

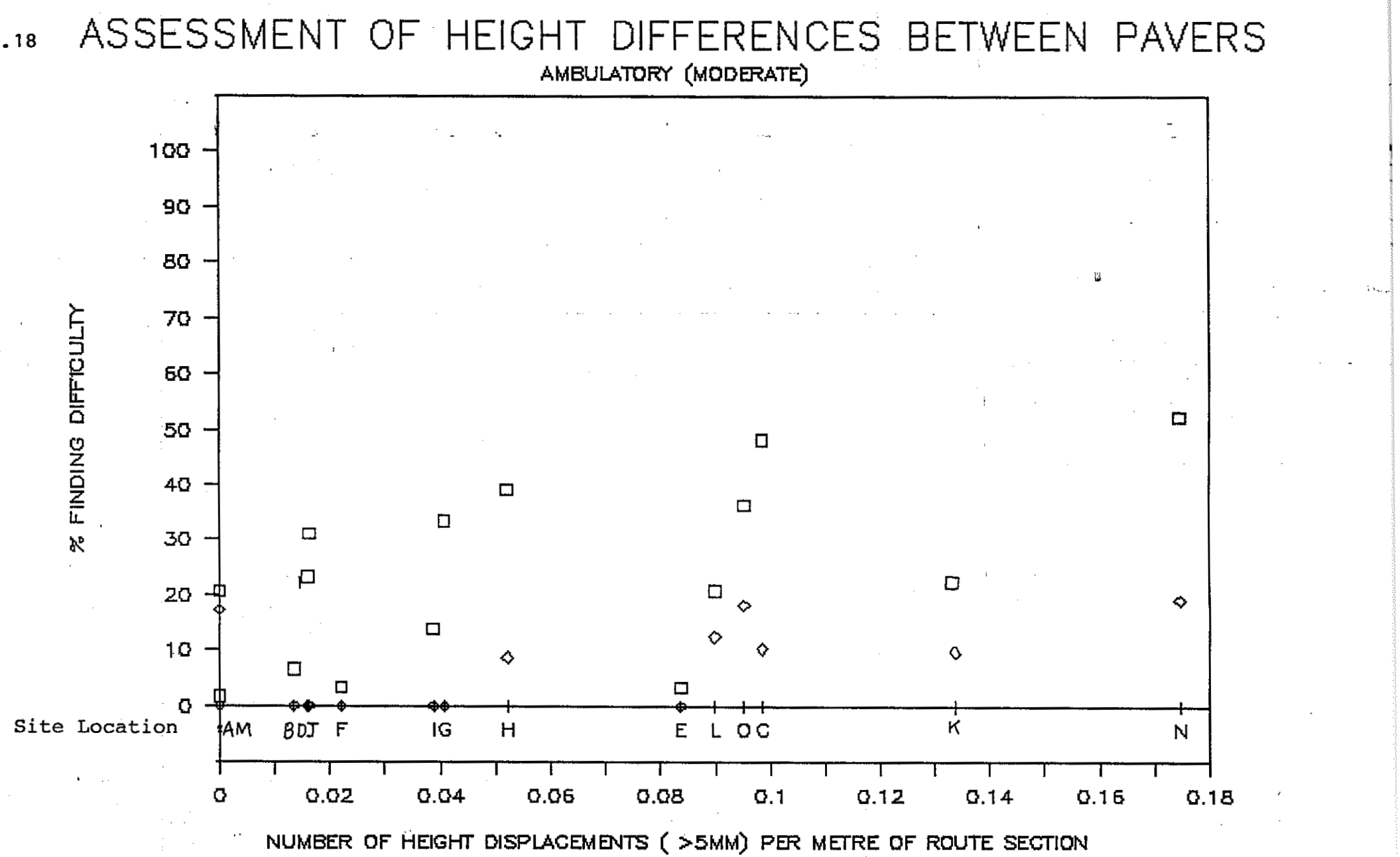

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS
AMBULATORY (MODERATE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
AM
BDJ
F
IG
H
E
L
O
C
K
N
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
NUMBER OF HEIGHT DISPLACEMENTS (>5MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.19

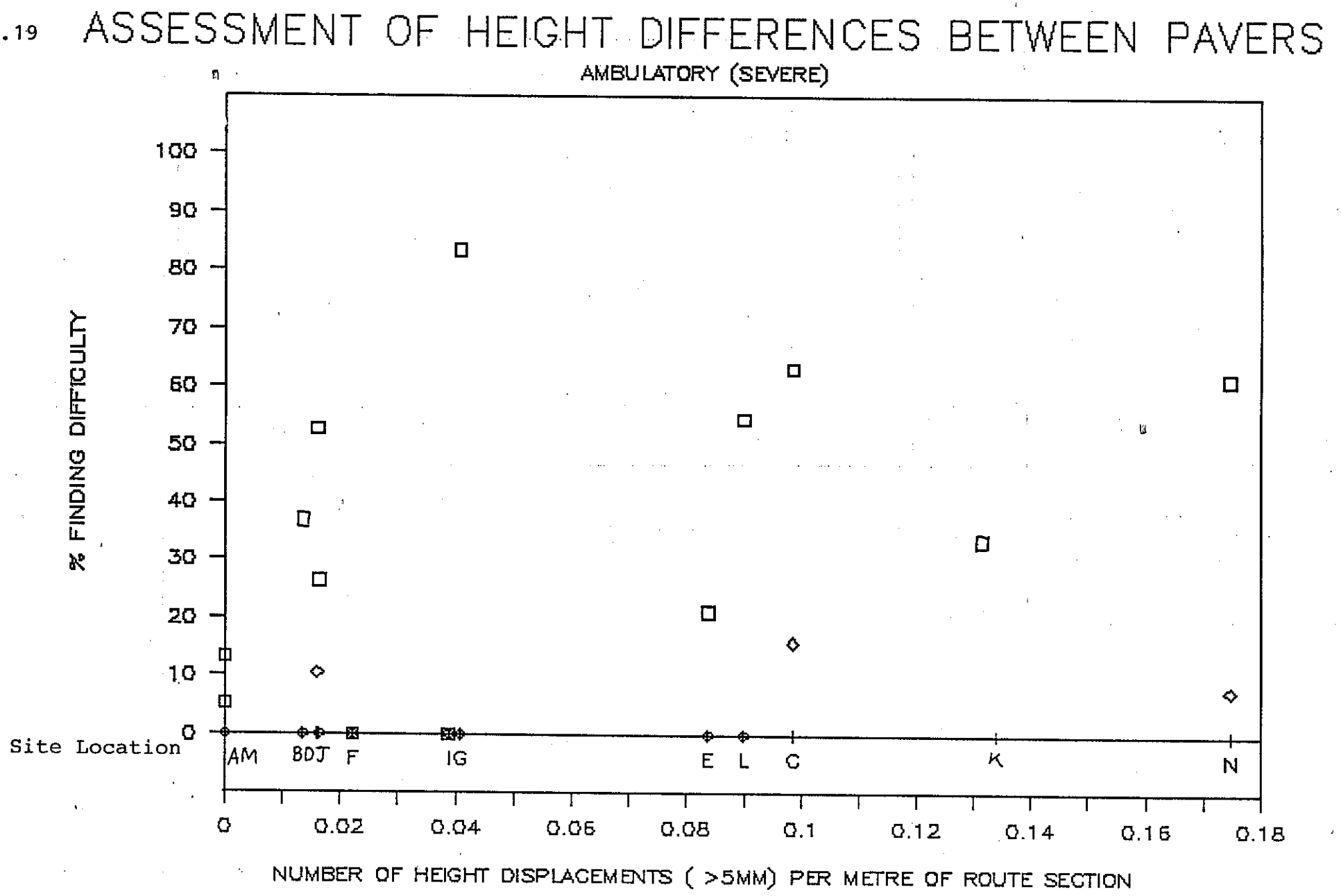

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS
AMBULATORY (SEVERE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
AM
BDJ
F
IG
E
L
C
K
N
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
NUMBER OF HEIGHT DISPLACEMENTS (>5MM) PER METRE OF ROUTE SECTION
At least some difficulty
Very difficult or impossible

Fig 3.20

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS

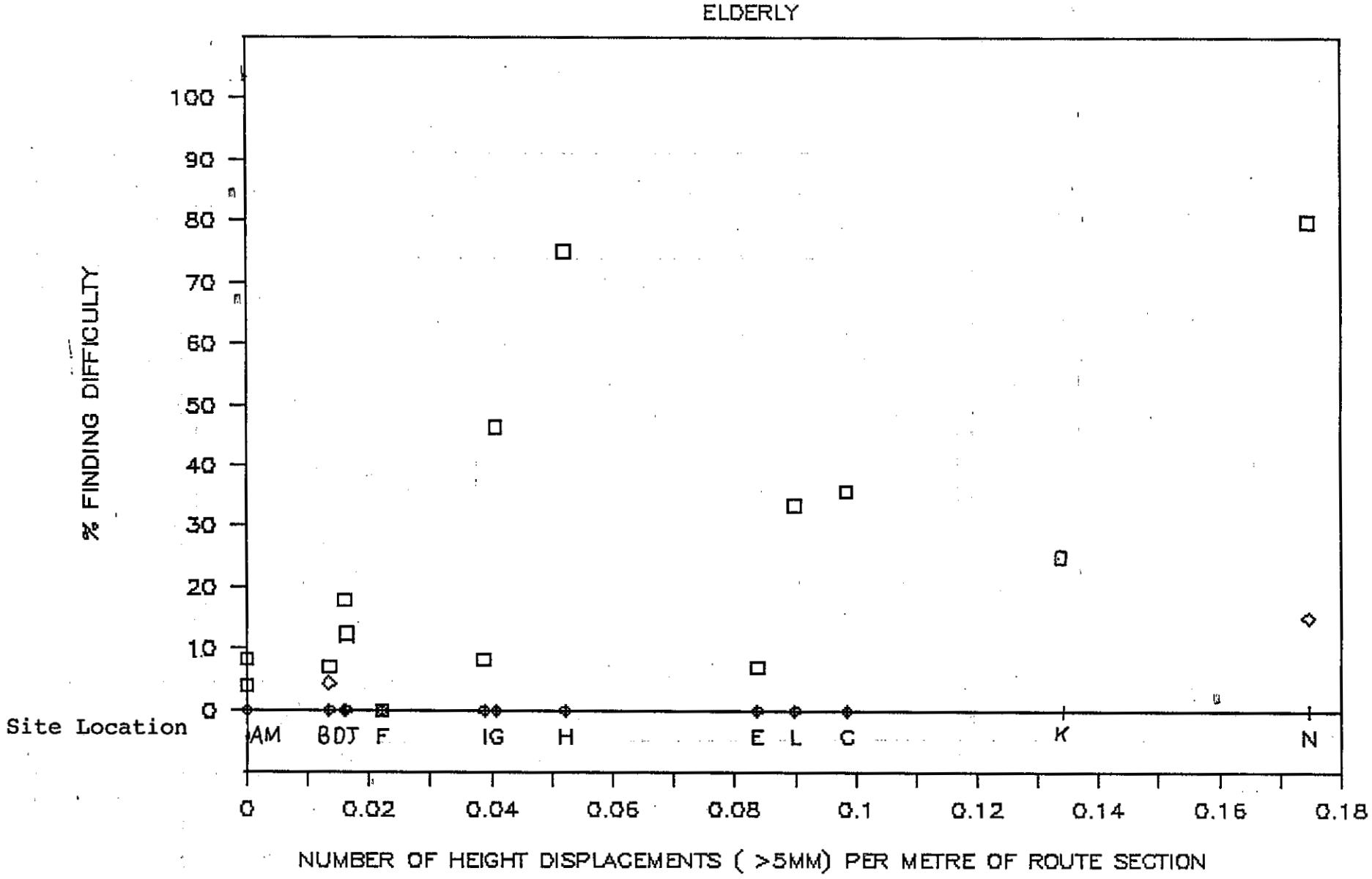


Fig 3.21

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS

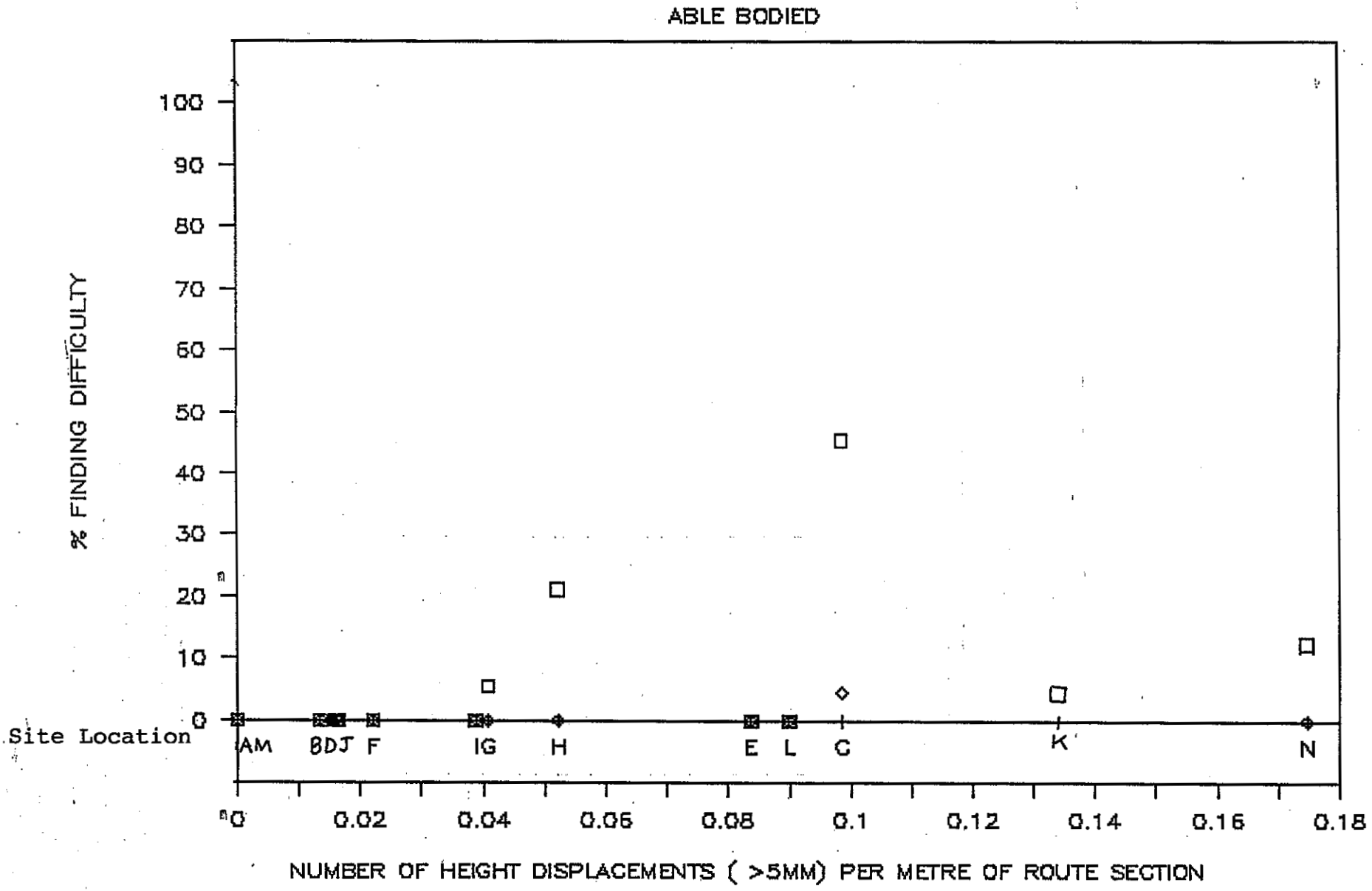
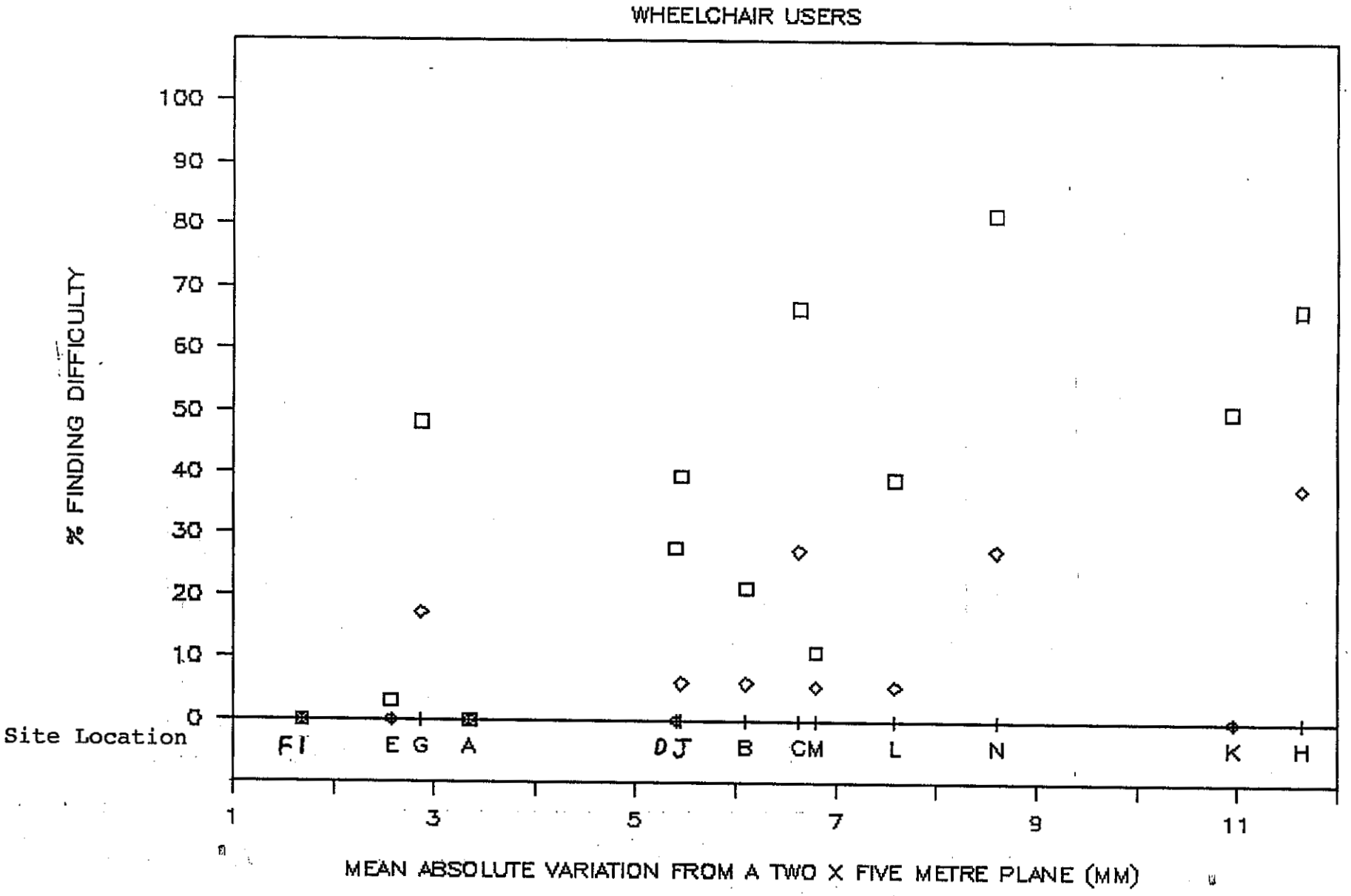


Fig 3.22

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS



□ At least some difficulty

◇ Very difficult or impossible

Fig 3.23

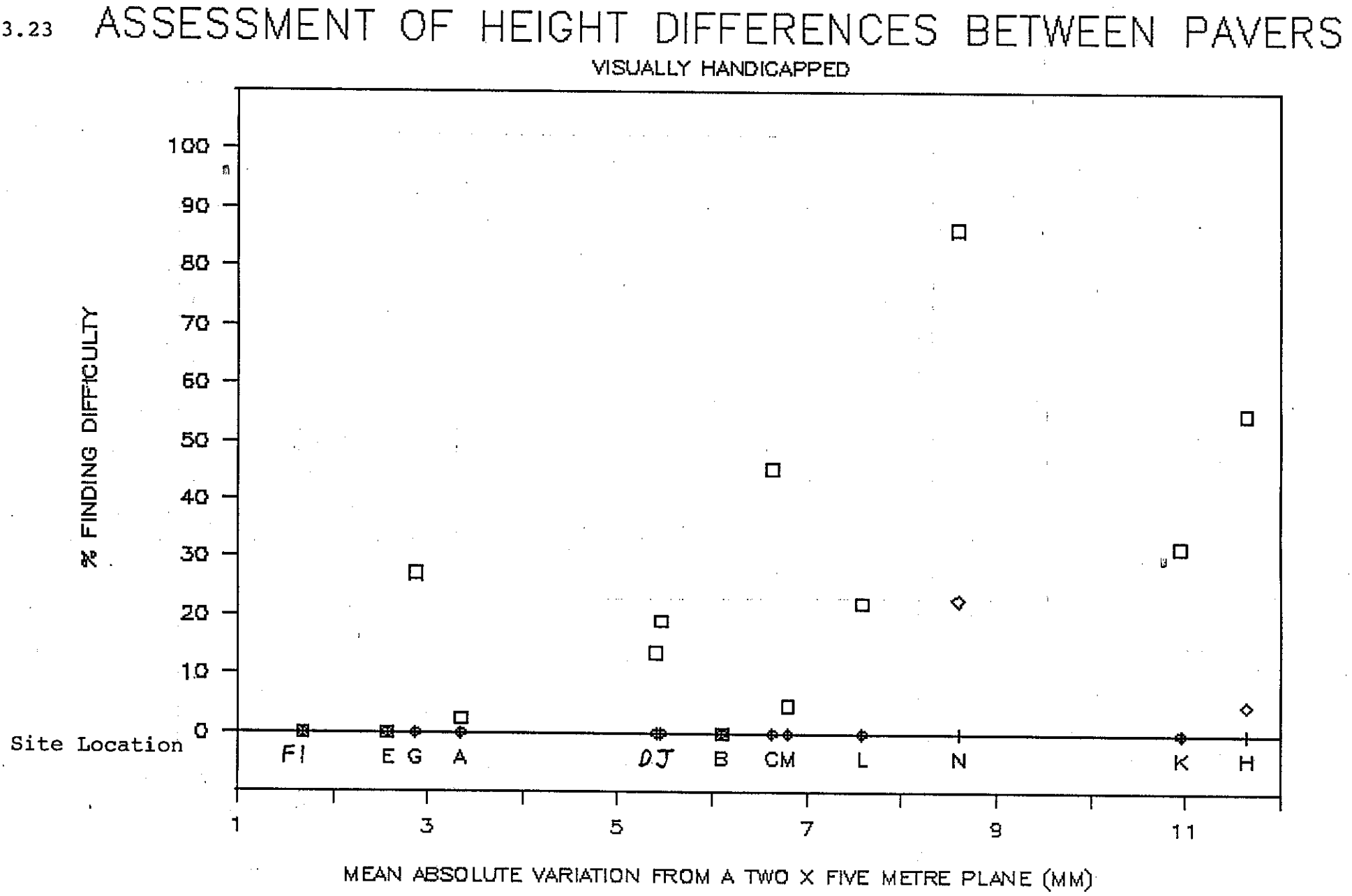
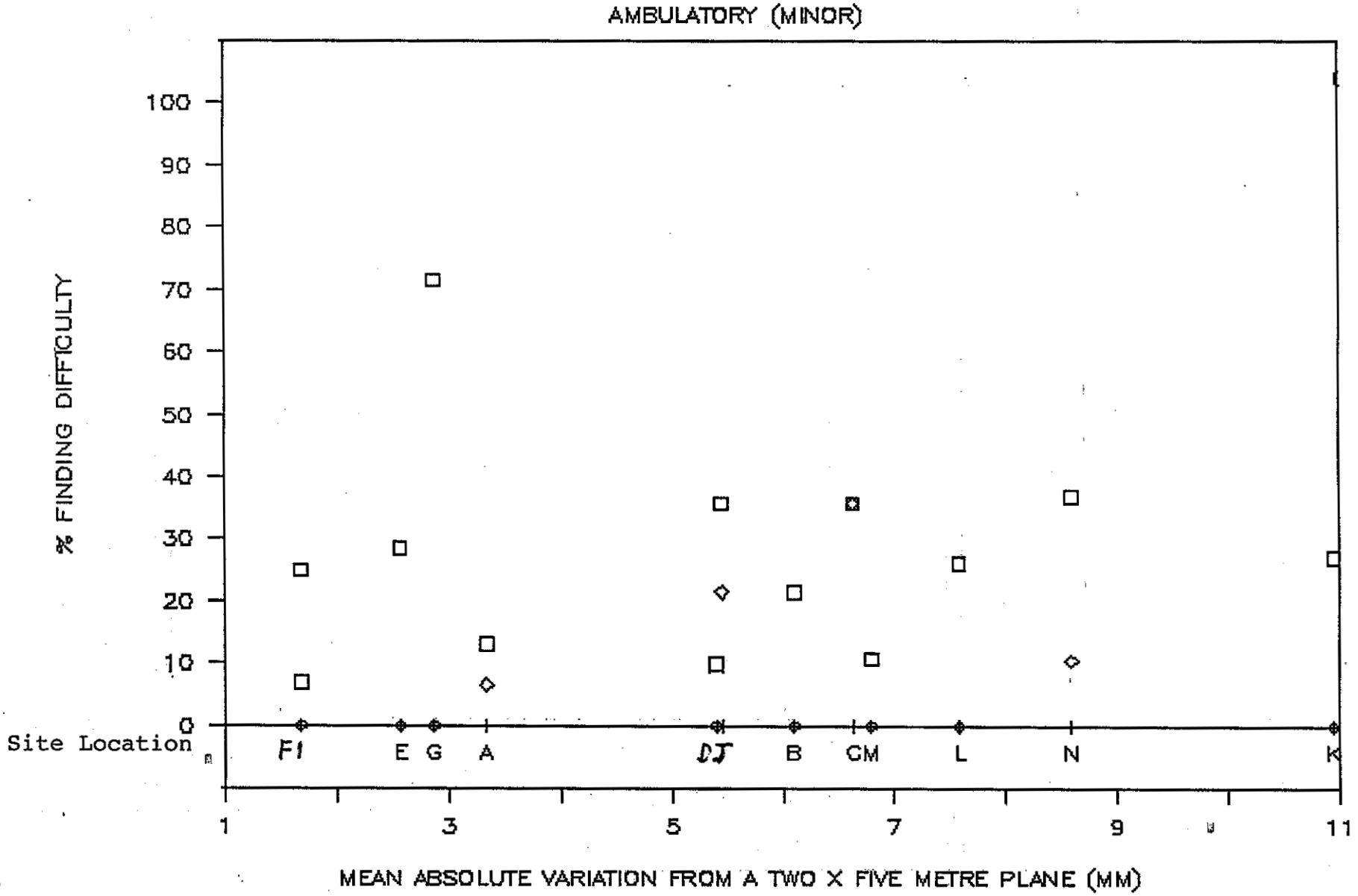

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS
VISUALLY HANDICAPPED
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
F!
E
G
A
DJ
B
CM
L
N
K
H
1
3
5
7
9
11
MEAN ABSOLUTE VARIATION FROM A TWO X FIVE METRE PLANE (MM)
At least some difficulty
Very difficult or impossible

Fig 3.24

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS



□ At least some difficulty

◇ Very difficult or impossible

Fig 3.25

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS

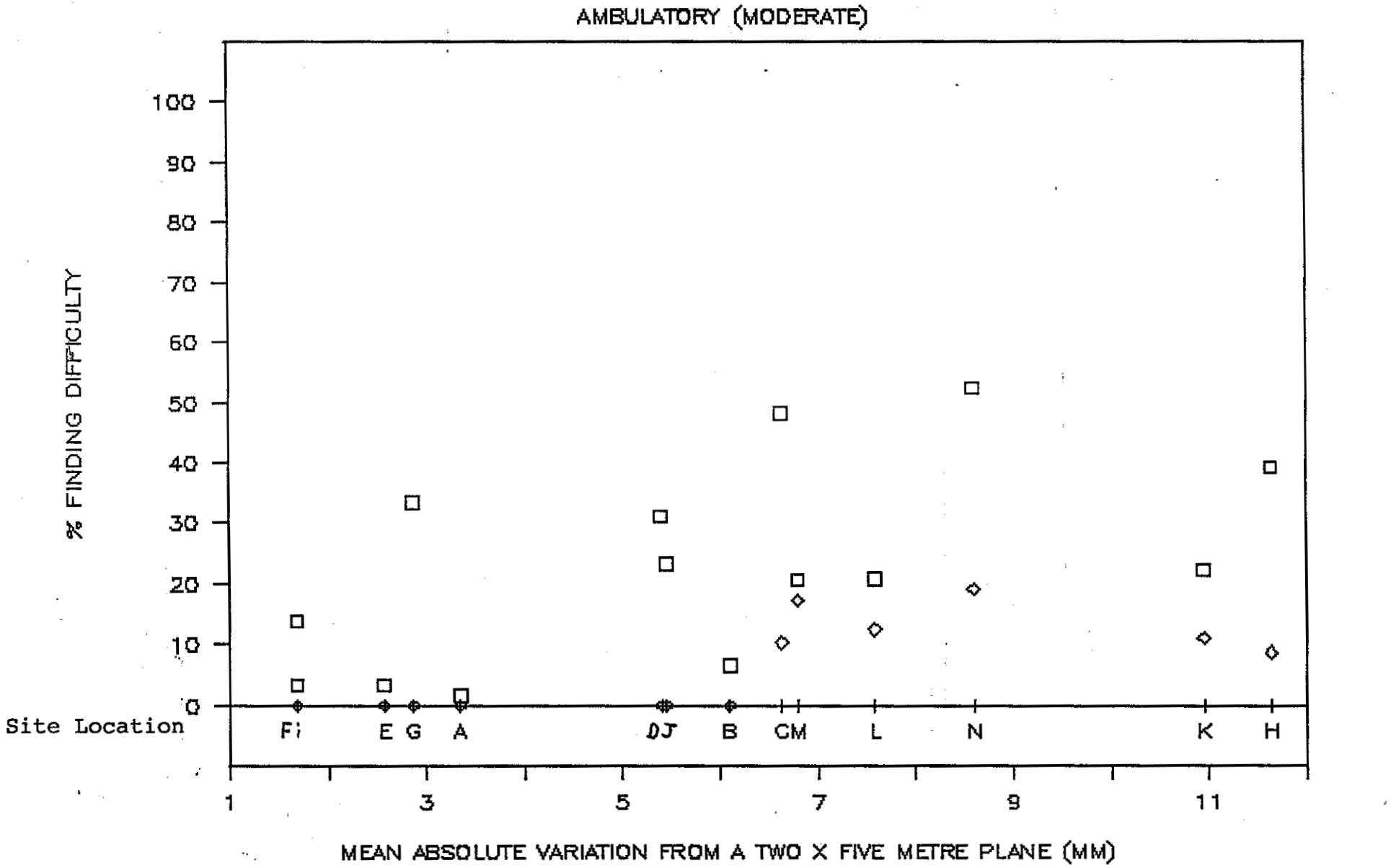


Fig 3.26

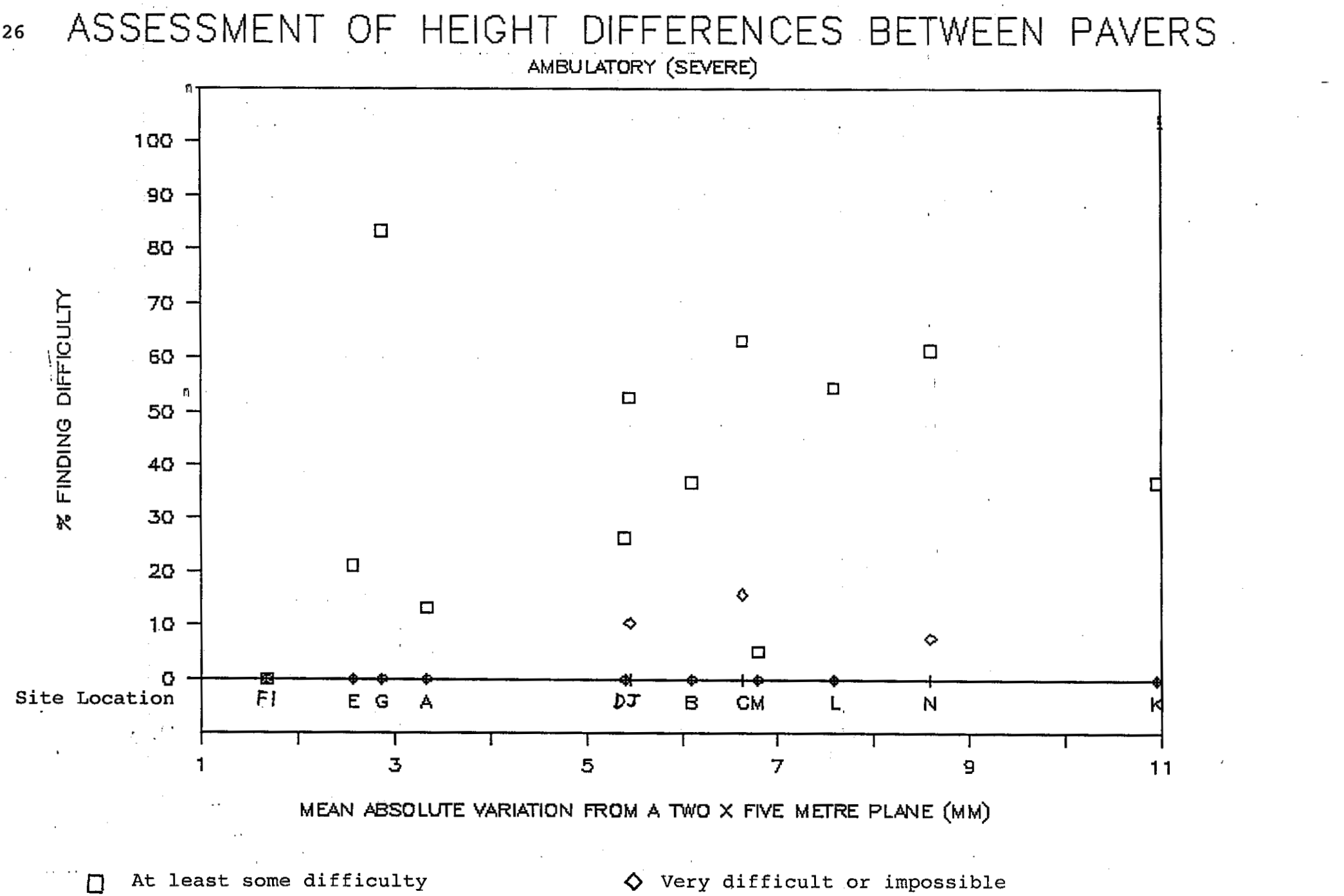

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS
AMBULATORY (SEVERE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
FI
E
G
A
DJ
B
CM
L
N
K
1
3
5
7
9
11
MEAN ABSOLUTE VARIATION FROM A TWO X FIVE METRE PLANE (MM)
At least some difficulty
Very difficult or impossible

Fig 3.27

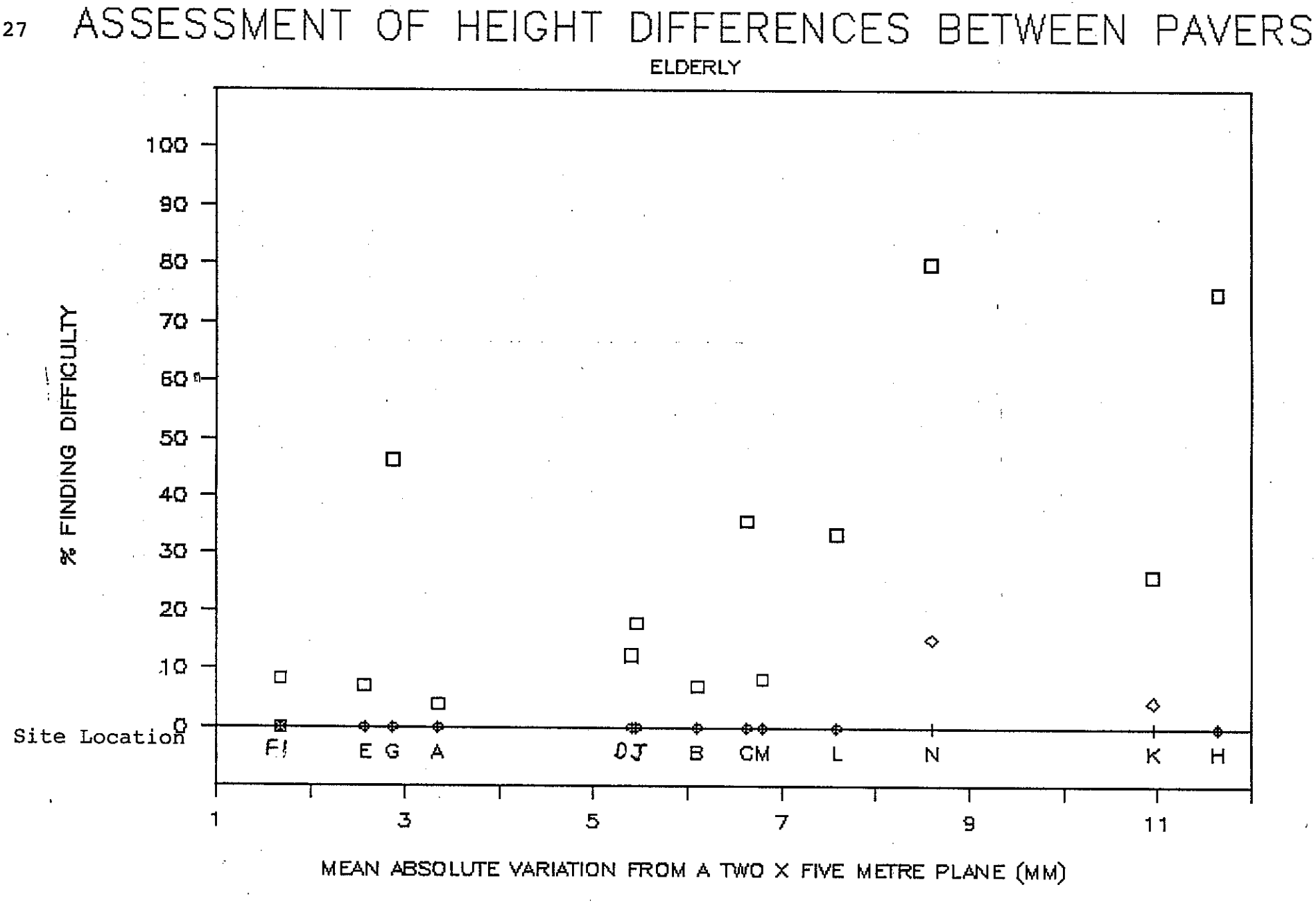
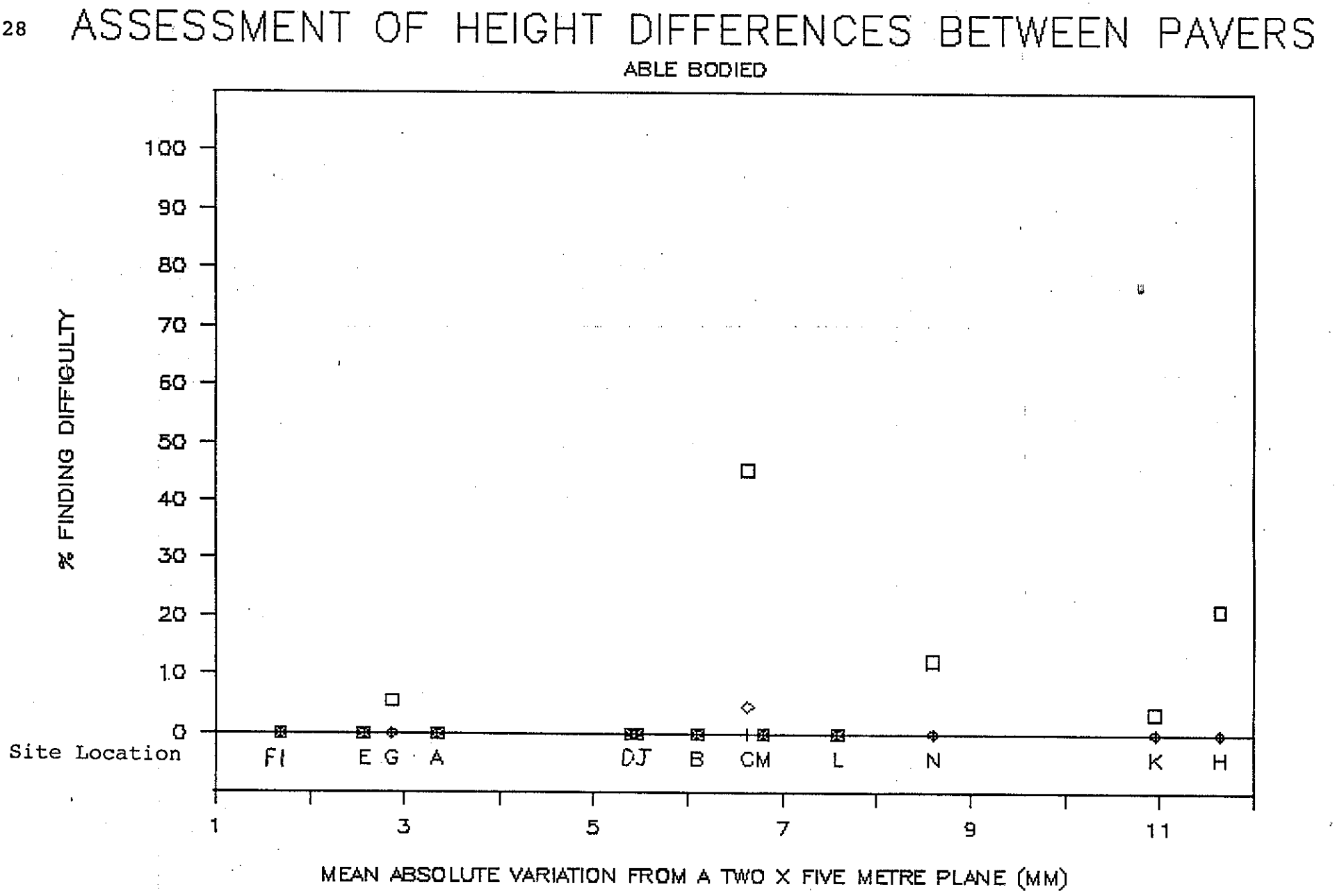

ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS
ELDERLY
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
F
E
G
A
D
J
B
C
M
L
N
K
H
1
3
5
7
9
11
MEAN ABSOLUTE VARIATION FROM A TWO X FIVE METRE PLANE (MM)
At least some difficulty
Very difficult or impossible

Fig 3.28


ASSESSMENT OF HEIGHT DIFFERENCES BETWEEN PAVERS
ABLE BODIED
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
FI
E
G
A
DJ
B
CM
L
N
K
H
1
3
5
7
9
11
MEAN ABSOLUTE VARIATION FROM A TWO X FIVE METRE PLANE (MM)
At least some difficulty
Very difficult or impossible

3.5 Assessment of Camber

There is substantial scatter of results associated with all categories of disability.

The wheelchair users alone, Fig 3.29, represent the type of findings that might be expected - increasing percentages with difficulty as cambers become more severe. This may be because cambers have more impact on wheelchair users than other groups or wheelchair users may have a clearer notion of the meaning of the term than members of other groups.

Second level difficulties are rarely reported.

Fig 3.29

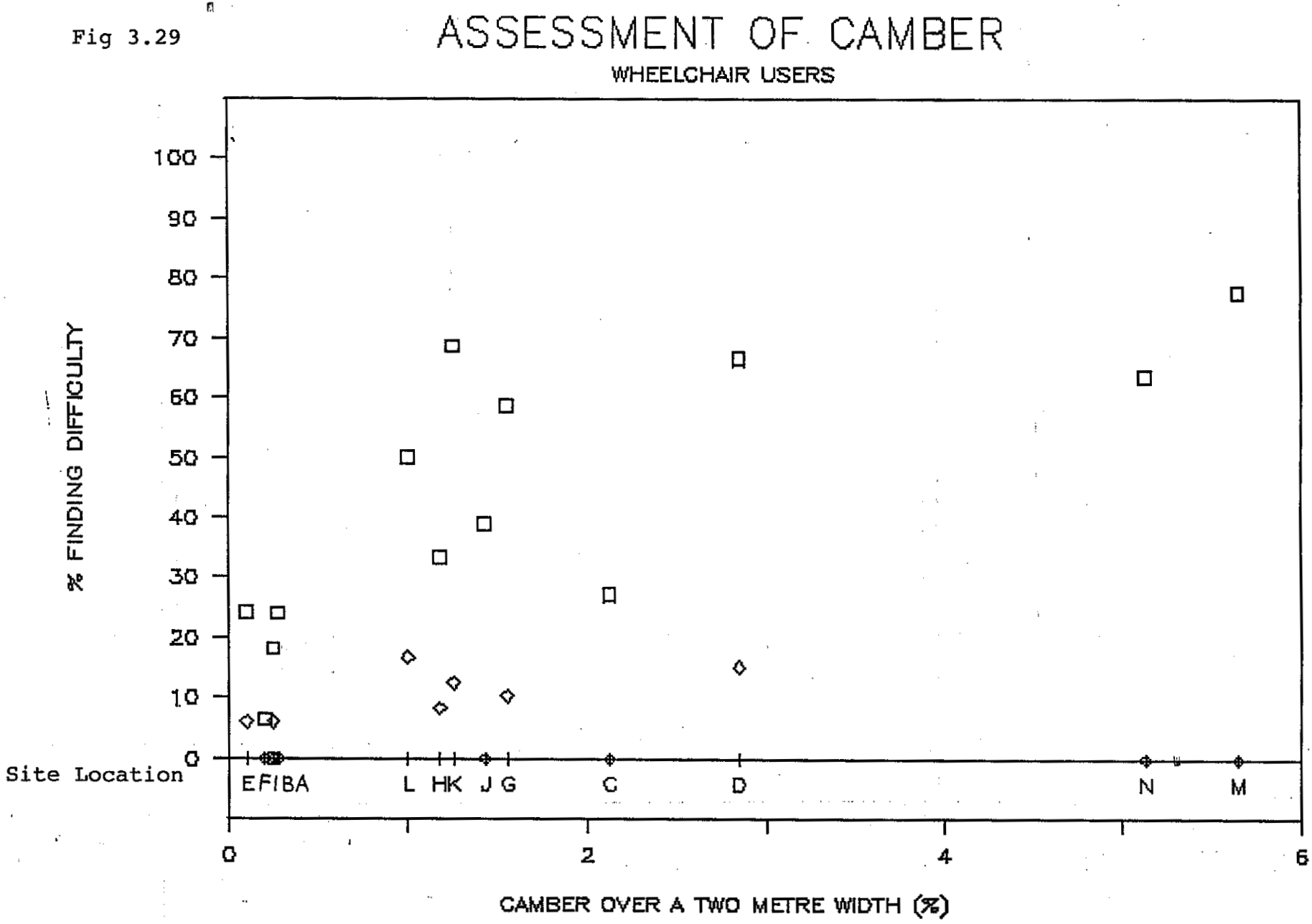

ASSESSMENT OF CAMBER
WHEELCHAIR USERS
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
EFIBA
L
HK
J
G
C
D
N
M
0
2
4
6
CAMBER OVER A TWO METRE WIDTH (%)
At least some difficulty
Very difficult or impossible

Fig 3.30

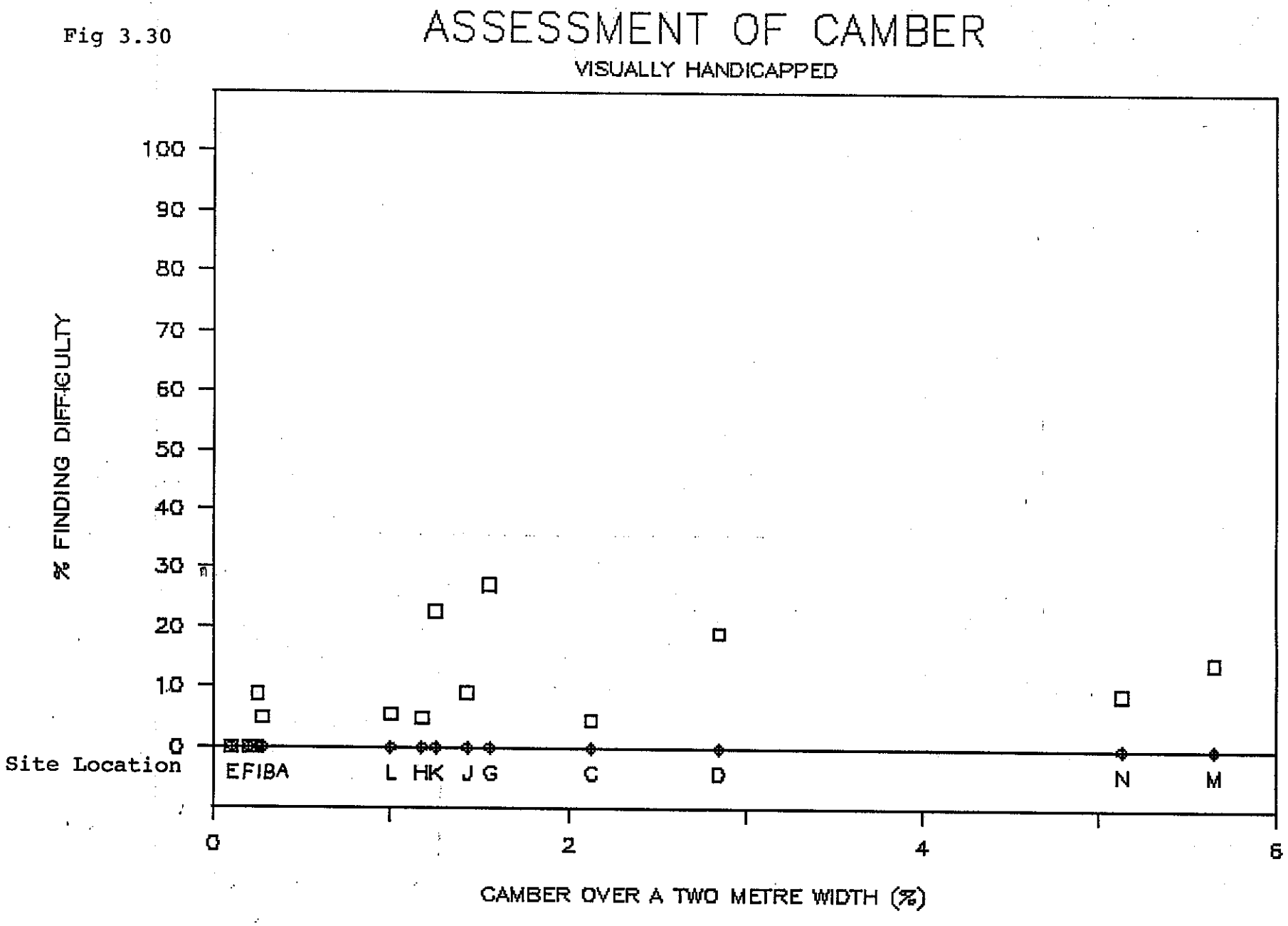

ASSESSMENT OF CAMBER
VISUALLY HANDICAPPED
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
EFIBA
L
HK
J
G
C
D
N
M
0
2
4
6
CAMBER OVER A TWO METRE WIDTH (%)
At least some difficulty
Very difficult or impossible

Fig 3.31

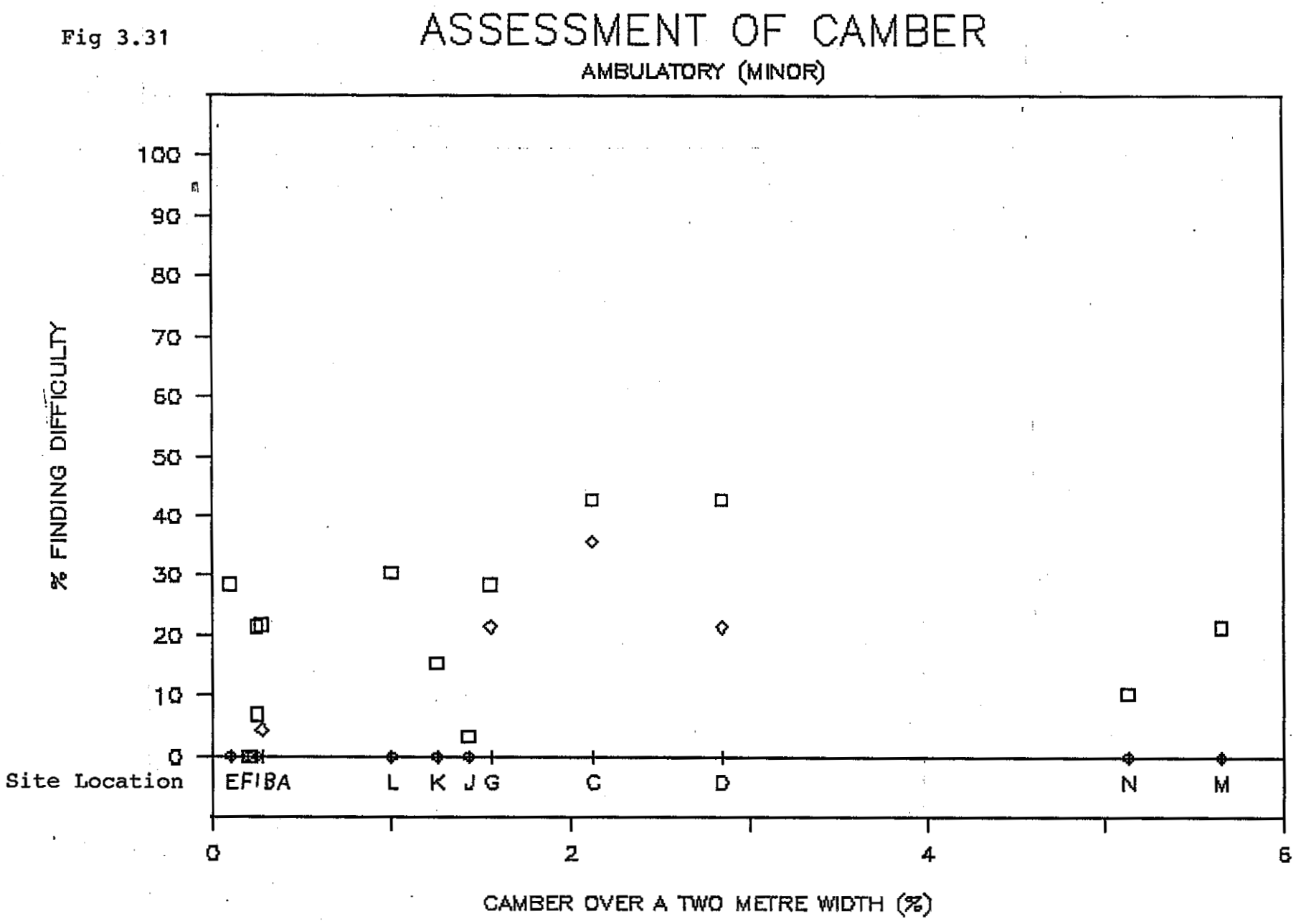

ASSESSMENT OF CAMBER
AMBULATORY (MINOR)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
EFIBA
L
K
J
G
C
D
N
M
0
2
4
6
CAMBER OVER A TWO METRE WIDTH (%)
At least some difficulty
Very difficult or impossible

Fig 3.32

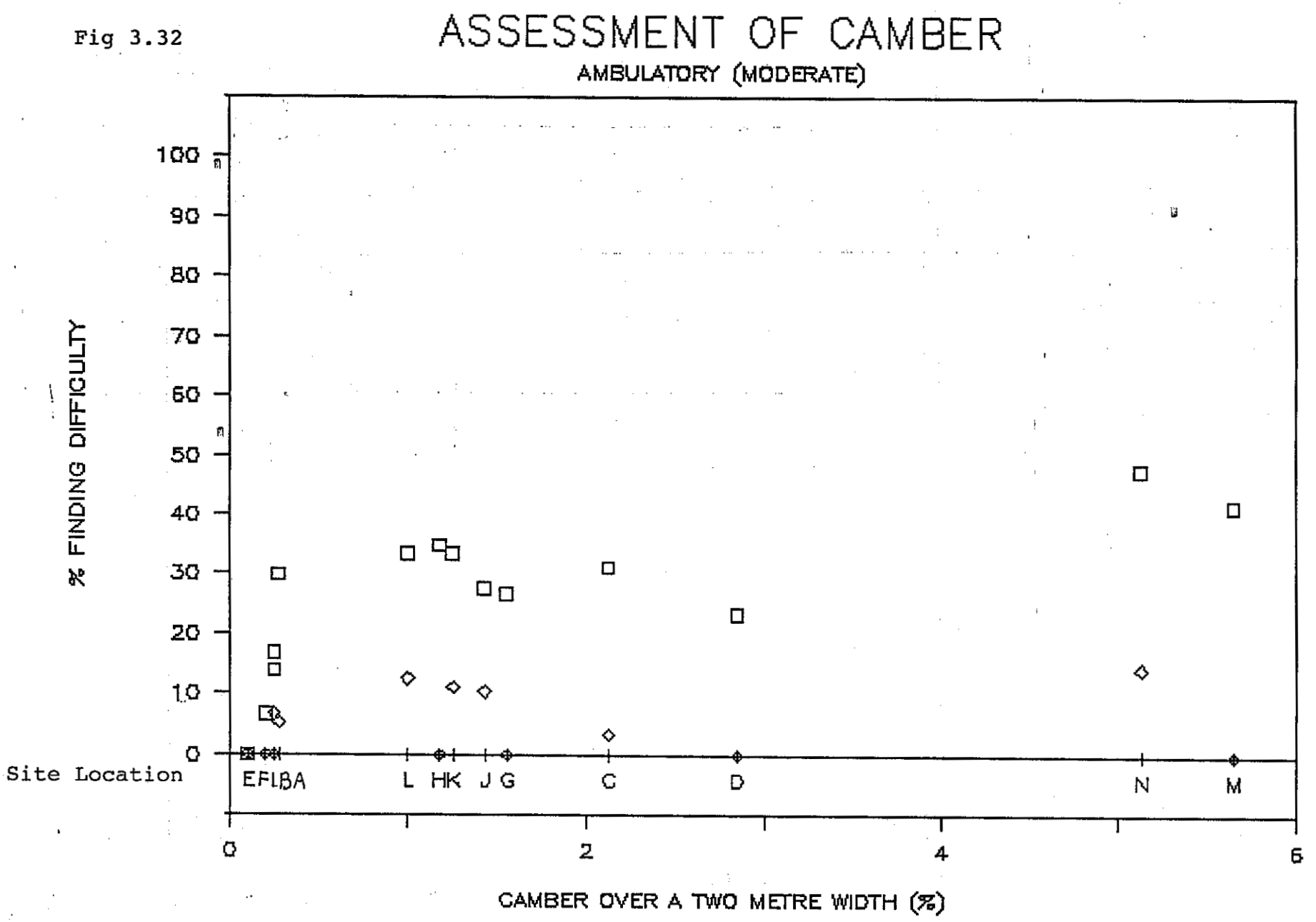

ASSESSMENT OF CAMBER
AMBULATORY (MODERATE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
EFIβA
L
HK
J
G
C
D
N
M
0
2
4
6
CAMBER OVER A TWO METRE WIDTH (%)
At least some difficulty
Very difficult or impossible

Fig 3.33

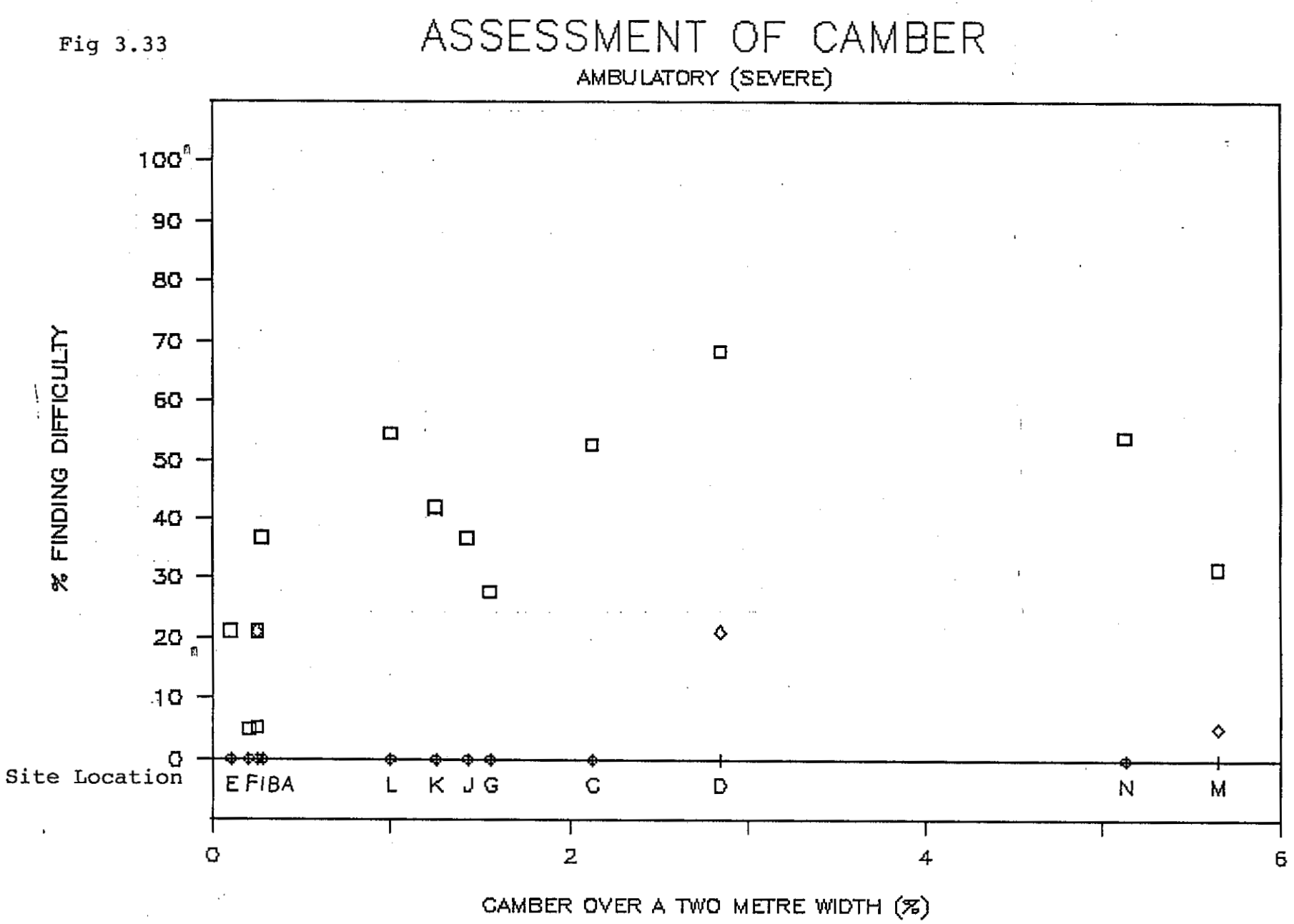

ASSESSMENT OF CAMBER
AMBULATORY (SEVERE)
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Location
E FIBA
L
K
J
G
C
D
N
M
0
2
4
6
CAMBER OVER A TWO METRE WIDTH (%)
At least some difficulty
Very difficult or impossible

Fig 3.34

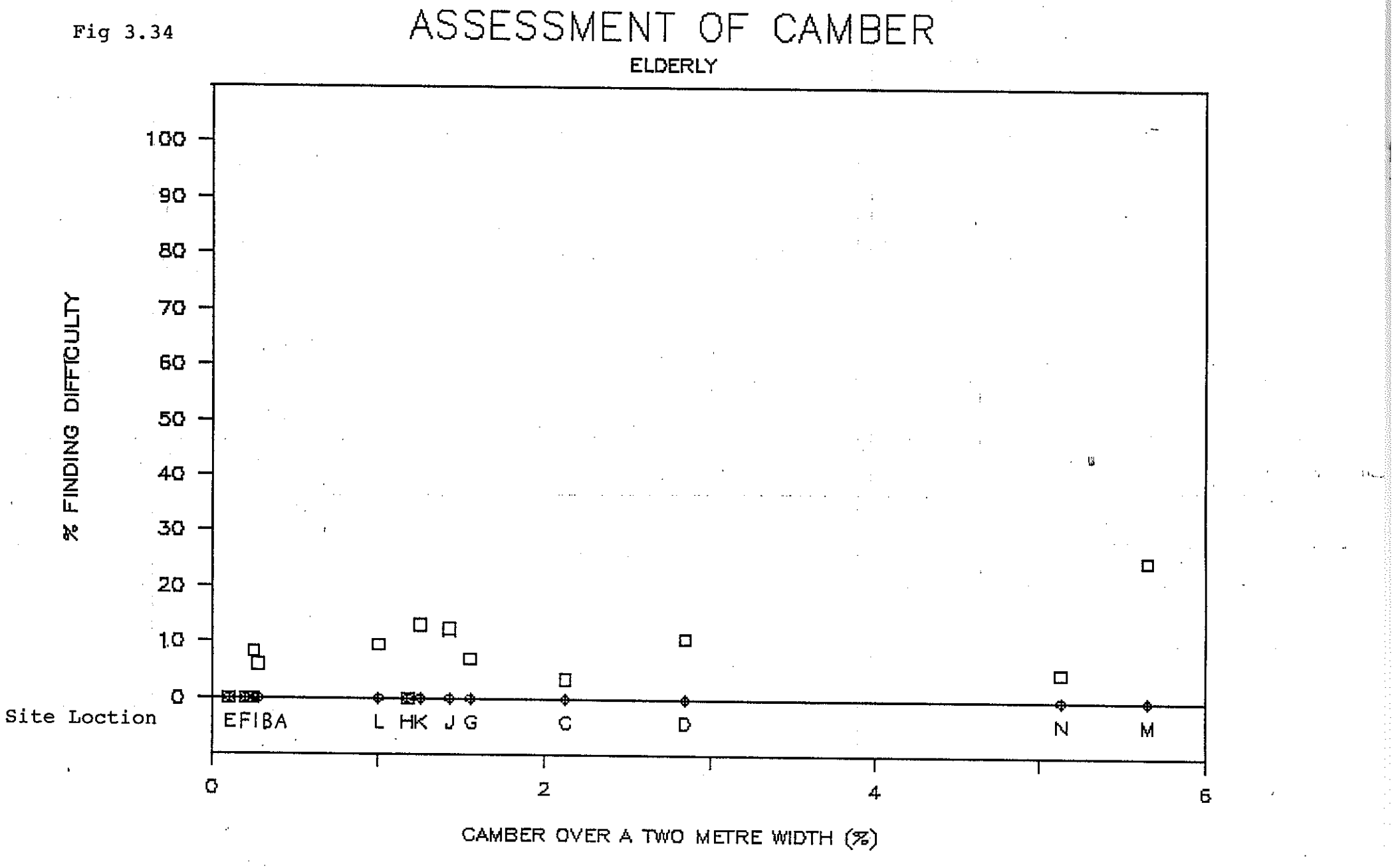
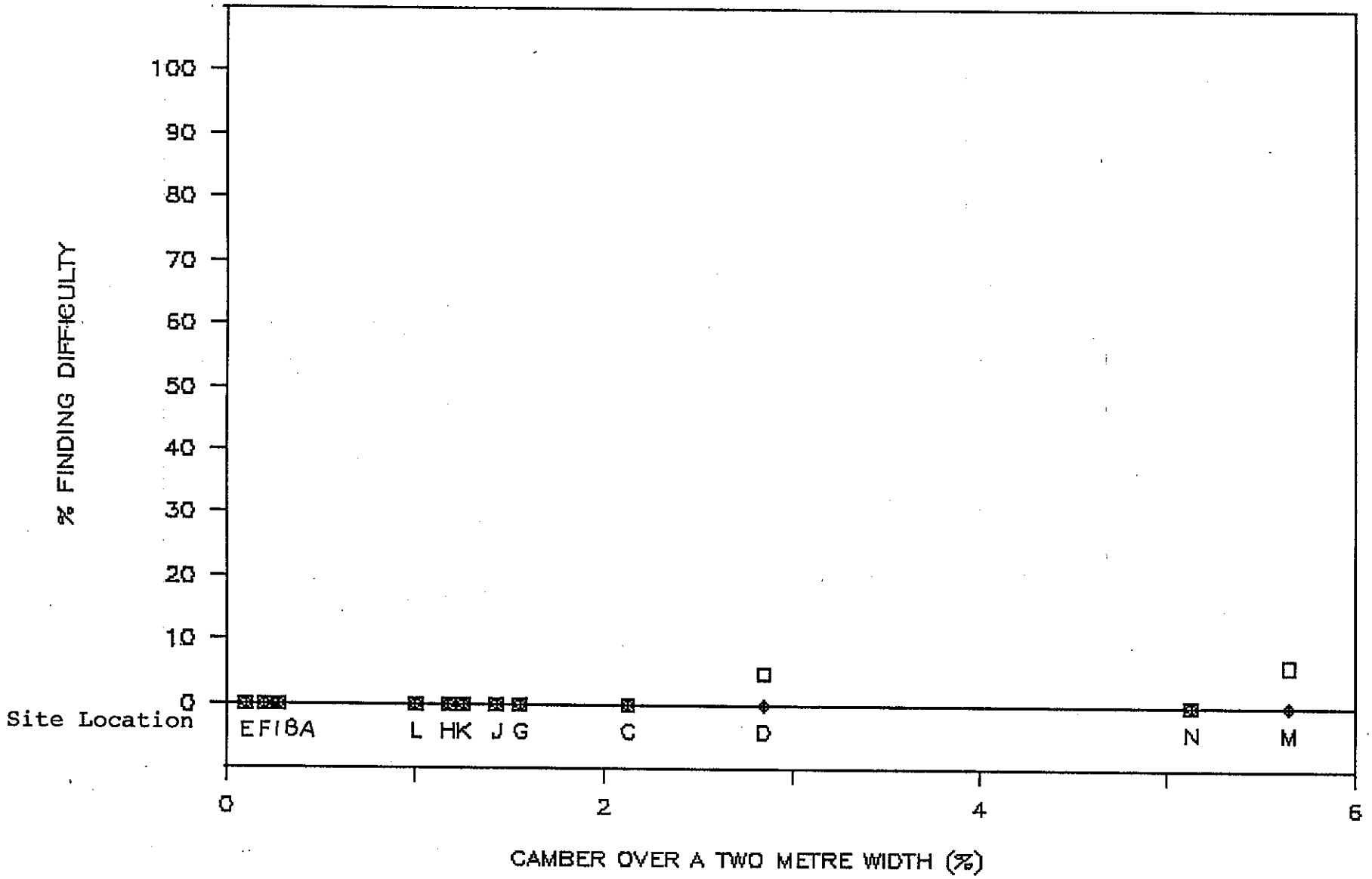

ASSESSMENT OF CAMBER
ELDERLY
% FINDING DIFFICULTY
100
90
80
70
60
50
40
30
20
10
0
Site Loction
EFIBA
L
HK
J
G
C
D
N
M
0
2
4
6
CAMBER OVER A TWO METRE WIDTH (%)
At least some difficulty
Very difficult or impossible

Fig 3.35

ASSESSMENT OF CAMBER

ABLE BODIED



□ At least some difficulty

◇ Very difficult or impossible

3.6 Slope Assessment, All Weather Conditions

There is substantial scatter for all categories of disability at both the first and second levels of difficulty although clear relationships between slope and difficulty can be seen. A general picture of decreasing difficulty can be found as the gradient approaches zero, with the lowest levels of difficulty found when there is a slight negative gradient, as represented at route sections F and M.

For the able bodied group, Fig 3.42, very little difficulty is found at any of the sites, as would be expected.

Route section K appears to get a higher difficulty rating by most of the groups. This may be because of intrusion of other route section characteristics into the assessment made by participants. Section K is a short but rather "rough" and obstructed area, and this may have been interpreted as gradient by participants.

The length of the gradients are not all the same. Both J and E are short in comparison to other gradients and this may have had the effect of reducing the levels of difficulty that were found.

The second level of difficulty, (those who reported that they found the gradient very difficult or impossible) was rarely used except by wheelchair users and ambulatory moderate or ambulatory severe groups, and did not follow any clear pattern.

Fig 3.36

SLOPE ASSESSMENT, ALL CONDITIONS

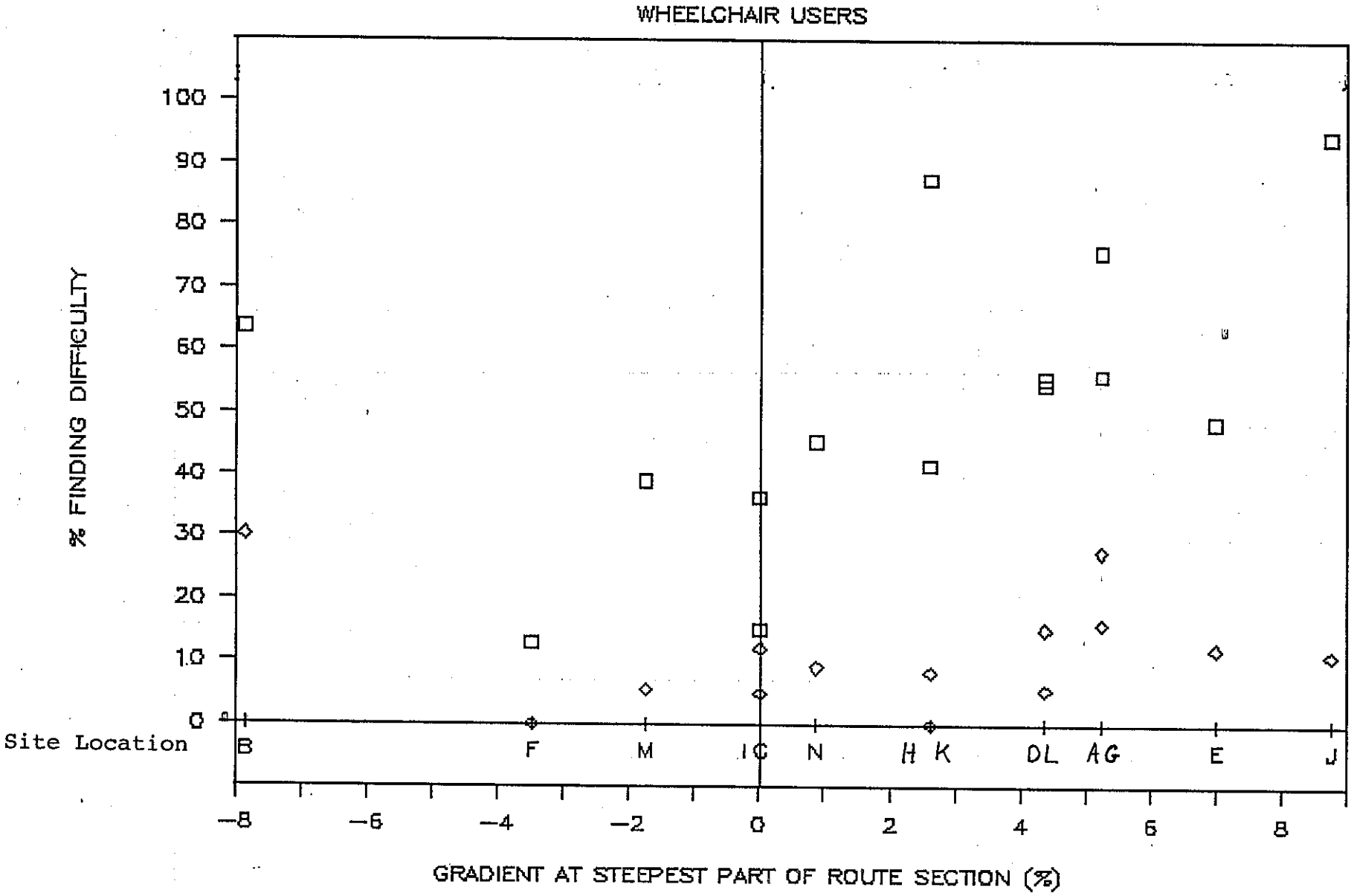
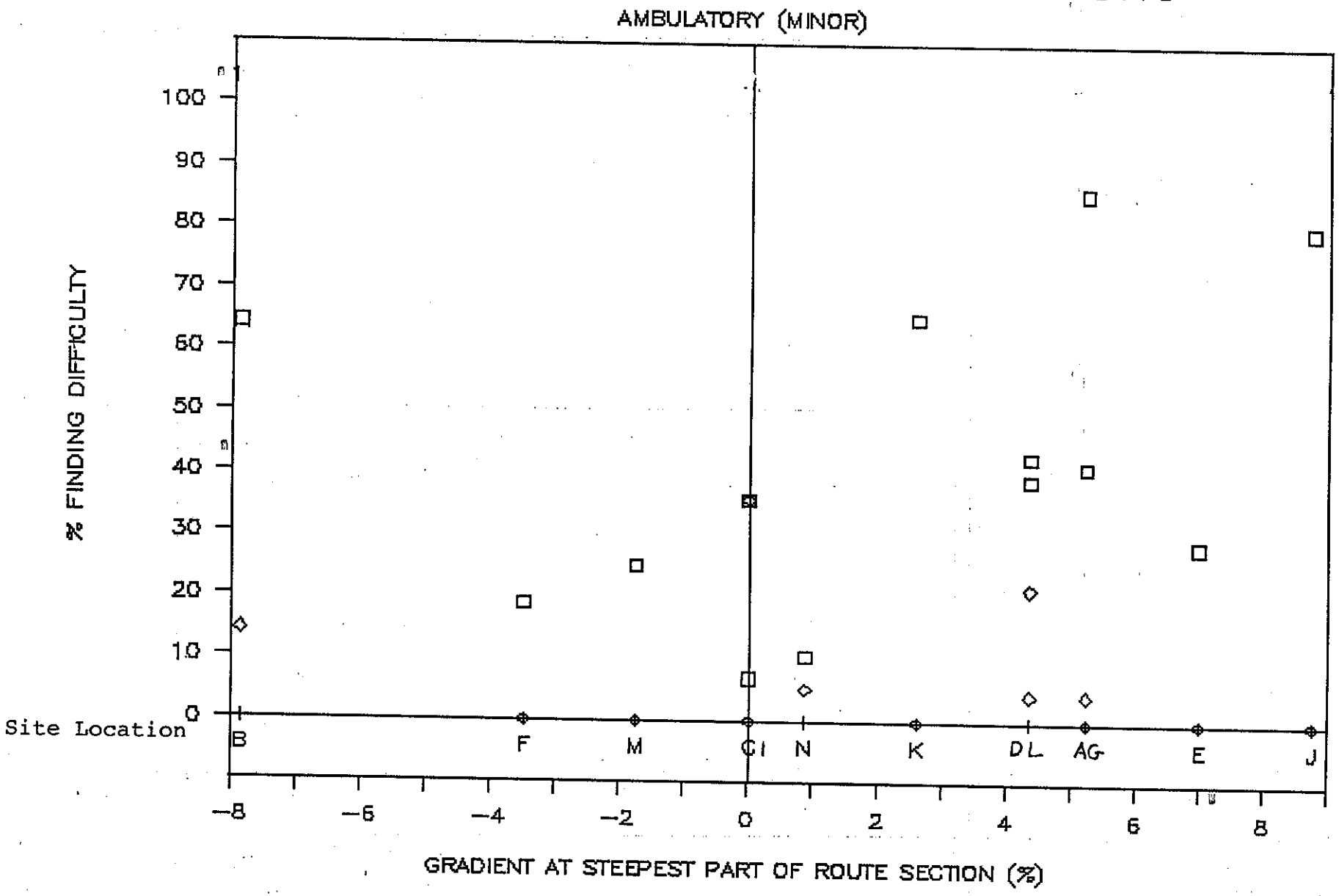


Fig 3.38

SLOPE ASSESSMENT, ALL CONDITIONS

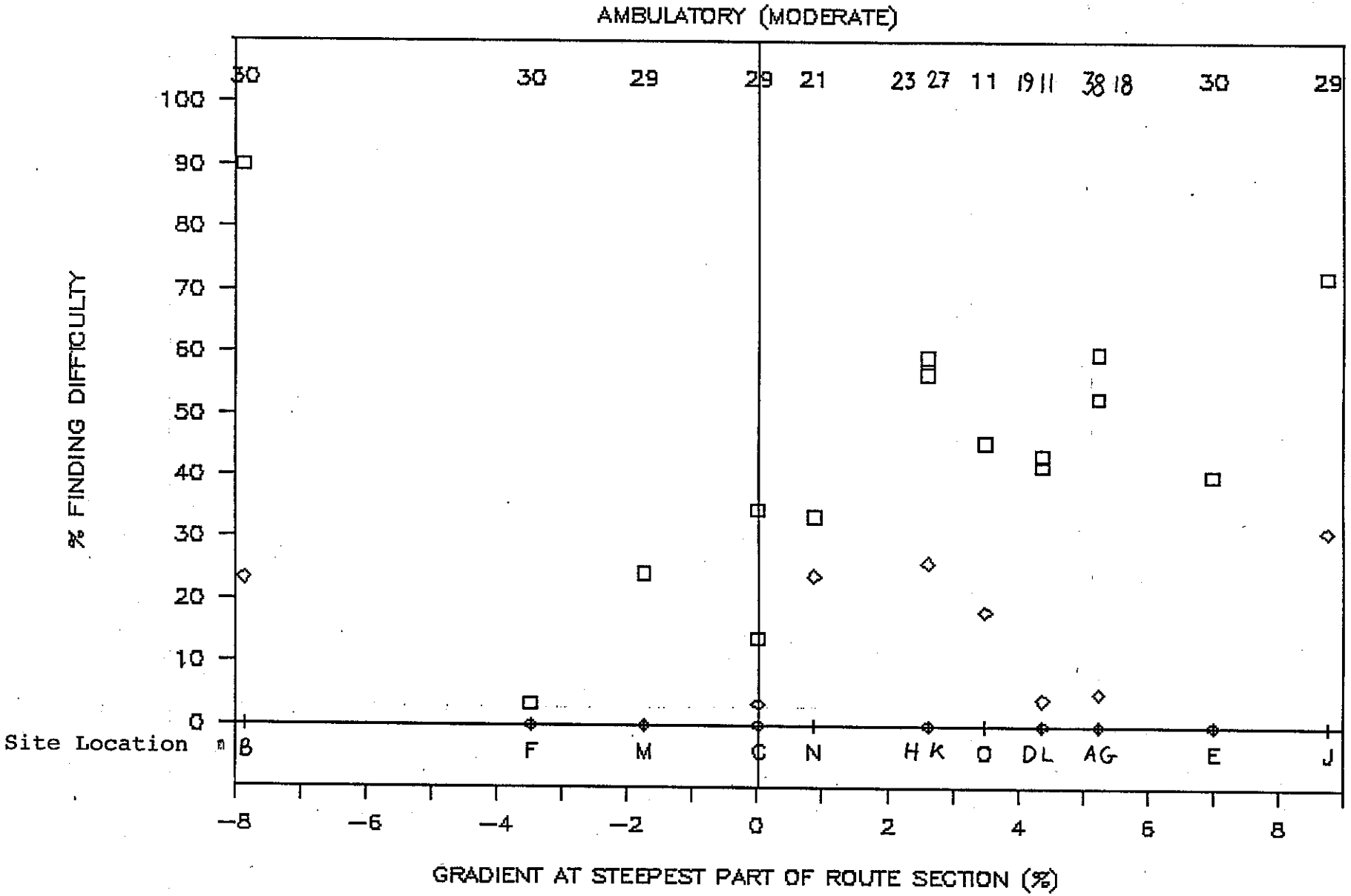


□ At least some difficulty

◇ Very difficult or impossible

Fig 3.39

SLOPE ASSESSMENT, ALL CONDITIONS



□ At least some difficulty

◇ Very difficult or impossible

Fig 3.40

SLOPE ASSESSMENT, ALL CONDITIONS

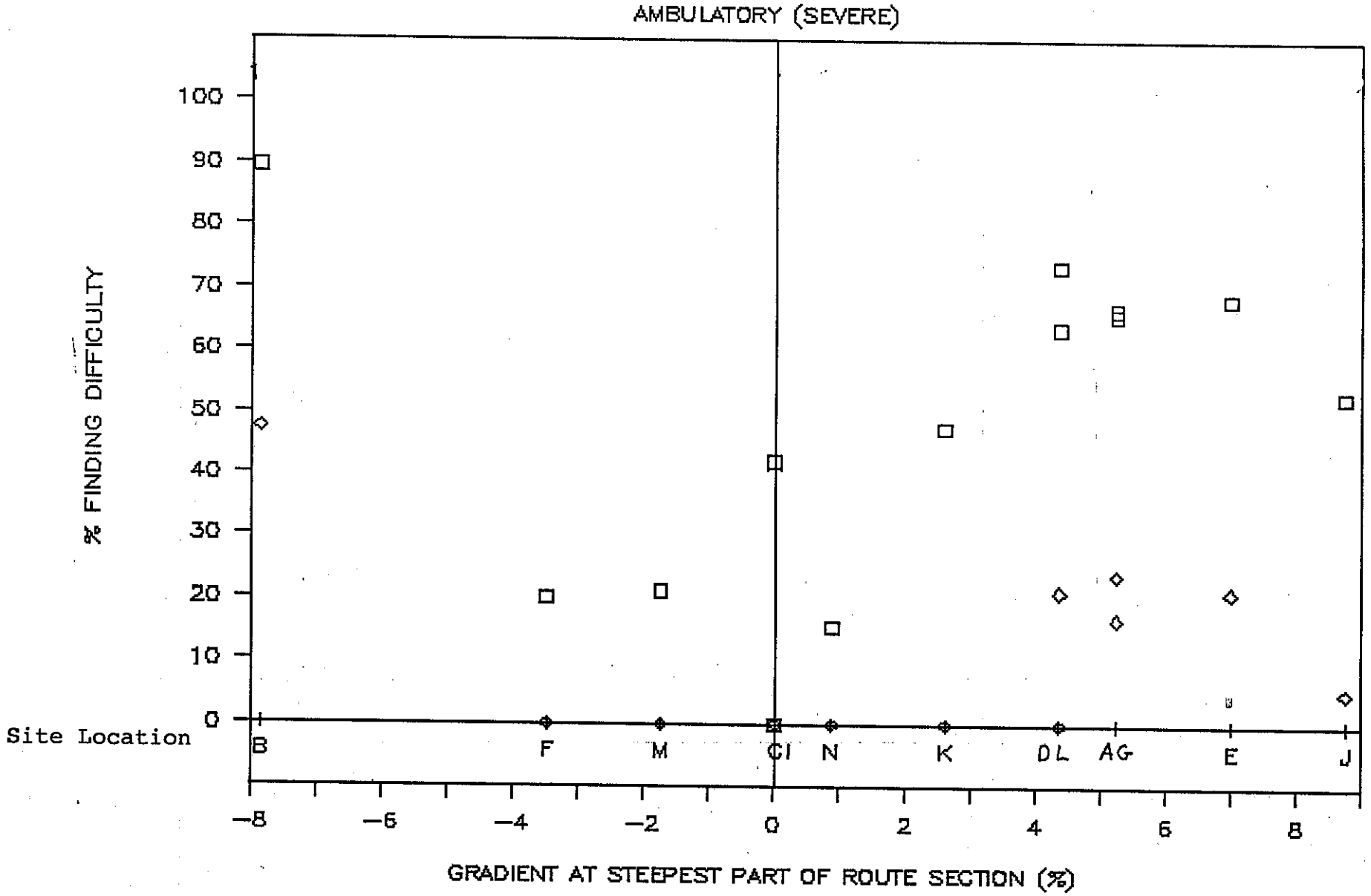
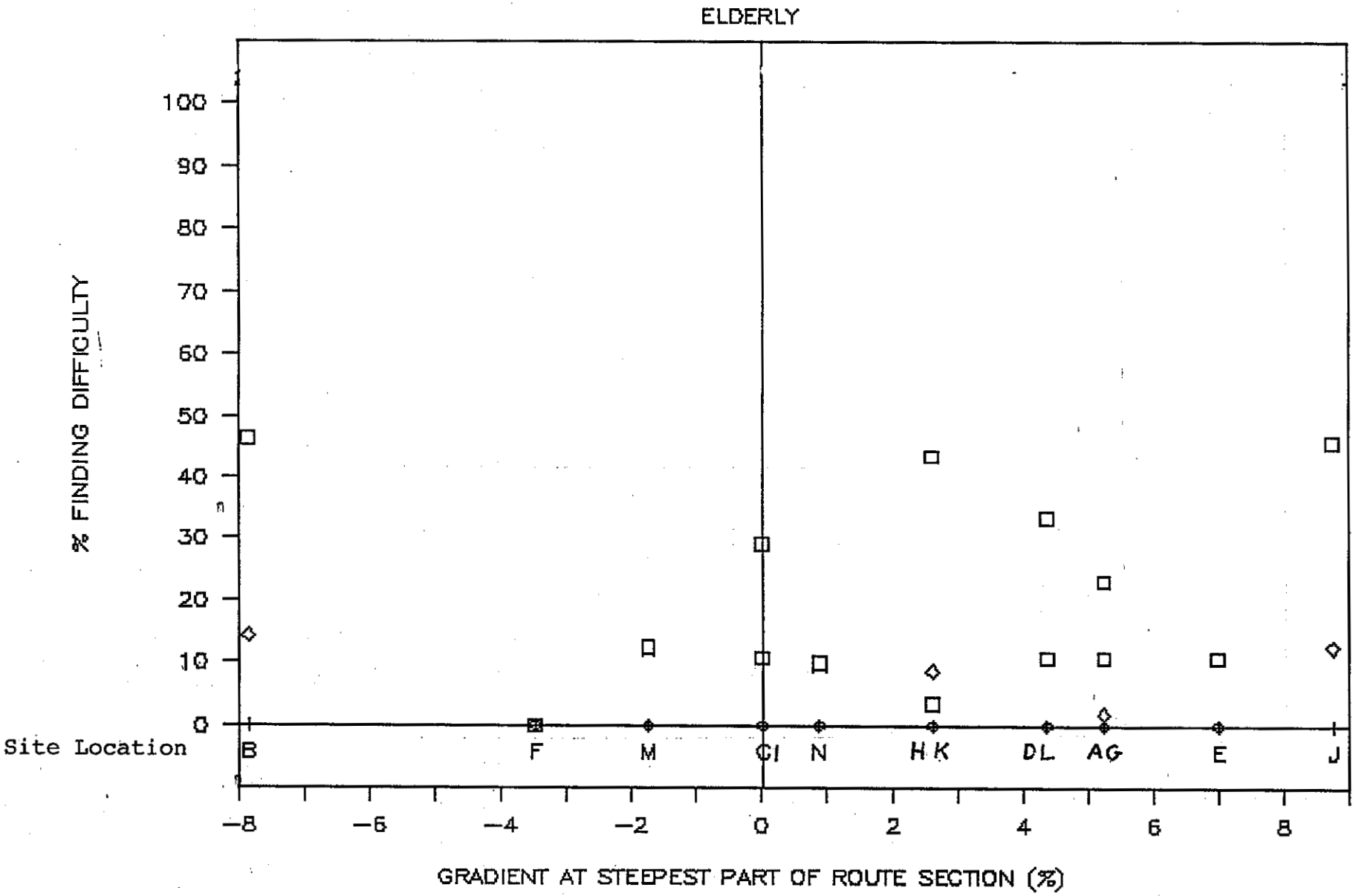


Fig 3.41

SLOPE ASSESSMENT, ALL CONDITIONS

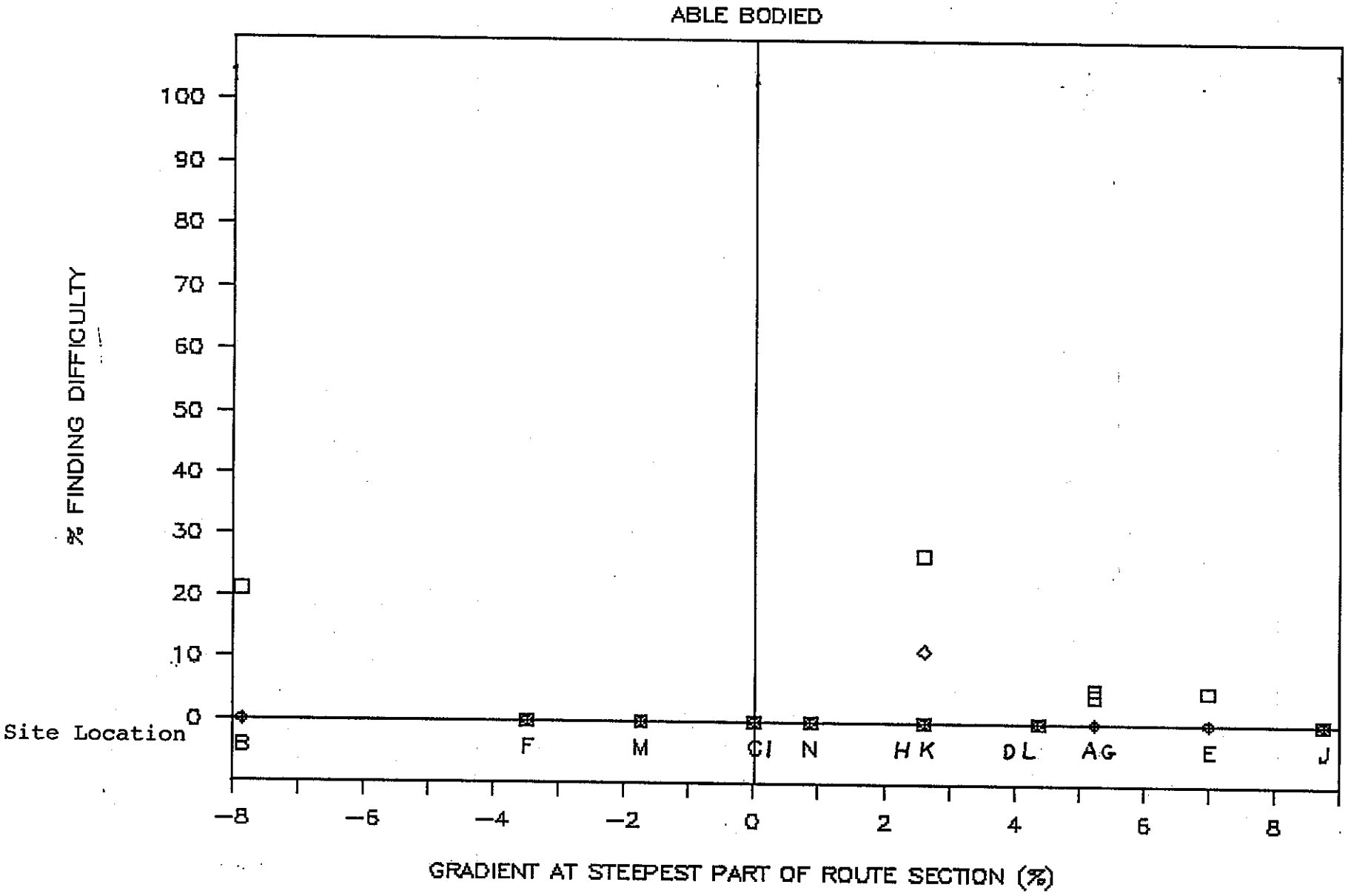


□ At least some difficulty

◇ Very difficult or impossible

Fig 3.42

SLOPE ASSESSMENT, ALL CONDITIONS



□ At least some difficulty

◇ Very difficult or impossible

3.7 Movement Distance Exercise

The first stage of the observation exercise was the movement distance exercise in which participants travelled 190m from the Fountain, the point at which they were dropped off after being collected from home, through a number of points at which they were timed, to an end point at "Merrie England" where refreshments were provided. The median time taken by each of the disability groups to complete the exercise is given below, and clearly shows the greater time required by disabled people to travel over a fixed distance than was required by able-bodied people.

It was found that there was no slowing down over the length of the exercise. Very few stops for rests were made over the length of movement distance exercise, although this result must be treated with suspicion because of the problem of participants' awareness of timings being made.

	Time taken to cover movement distance route (seconds)
Wheelchair User	290
Visually Handicapped	310
Ambulatory Minor	300
Ambulatory Moderate	360
Ambulatory Severe	360
Elderly	350
Able-bodied	160

3.8 Slowness Related to Distance Travelled

The starting and finishing times at each route section were recorded for all participants. The times were compared to the length of the route sections, to give a measure of slowness - the time taken to cover a unit distance.

It was thought possible that there would be an increase in slowness in later route sections as participants became fatigued.

Participants were invited to travel over one of two different routes, and so two Figures are presented for each disability category, one for each of the possible routes.

Each of the Figures shows the spread of slowness found:

10th percentiles are represented by □
25th " " " " +
50th " " " " ◇
75th " " " " △
90th " " " " X

No general increase in slowness is apparent towards latter parts of the route sections for either route or for any disability category.

The figures reveal substantial differences in slowness within and between groups.

As might be expected the able bodied group, Fig 3.56, are the least slow, and demonstrate a narrow range of speeds.

All the groups show that the quickest moving within each of the groups travelled at about the same speed as the able bodied group, but that there was a wide range of speeds. This is particularly pronounced among the wheelchair users and ambulatory (severe) groups, Fig 3.43 and 3.47.

In the shorter route a greater range of speeds is shown; particularly at route section K which is a section of route particularly obstructed by bollards and other impediments.

Fig 3.43

SLOWNESS RELATED TO DISTANCE TRAVELLED

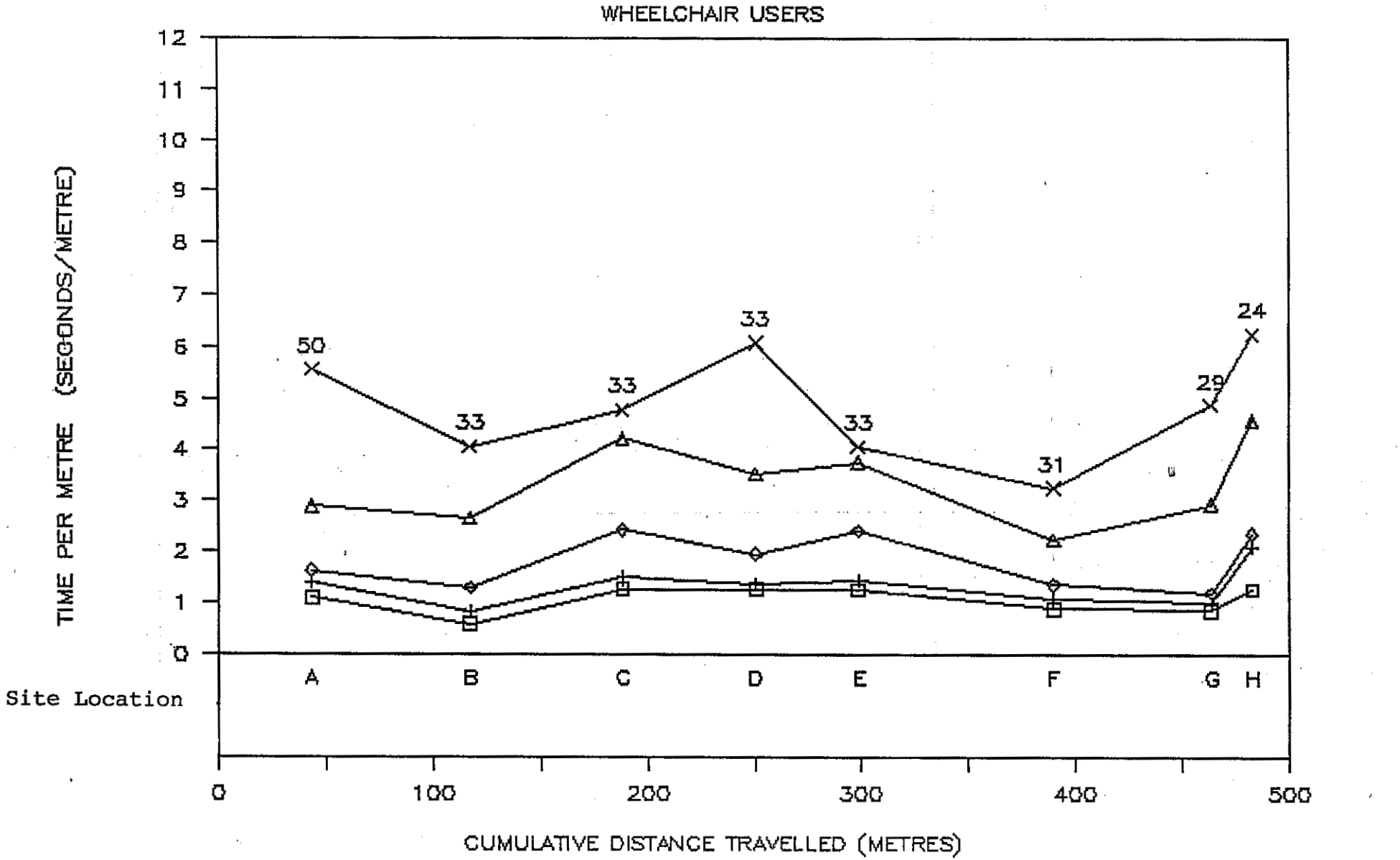


Fig 3.44

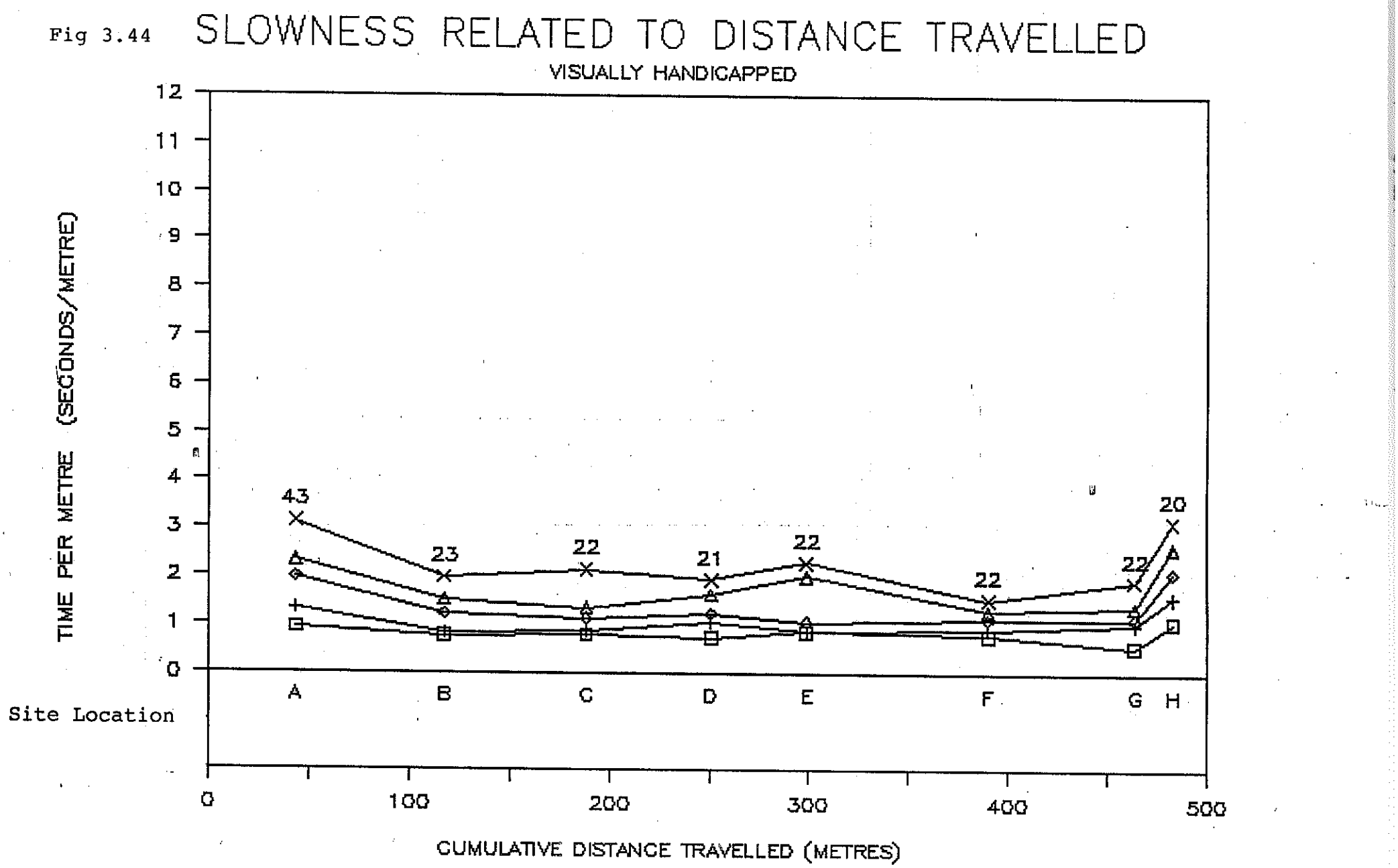

SLOWNESS RELATED TO DISTANCE TRAVELLED
VISUALLY HANDICAPPED
TIME PER METRE (SECONDS/METRE)
12
11
10
9
8
7
6
5
4
3
2
1
0
43
23
22
21
22
22
22
20
A
B
C
D
E
F
G
H
Site Location
0
100
200
300
400
500
CUMULATIVE DISTANCE TRAVELLED (METRES)
10th percentile
25th percentile
Median
75th percentile
90th percentile

Fig 3.45

SLOWNESS RELATED TO DISTANCE TRAVELLED

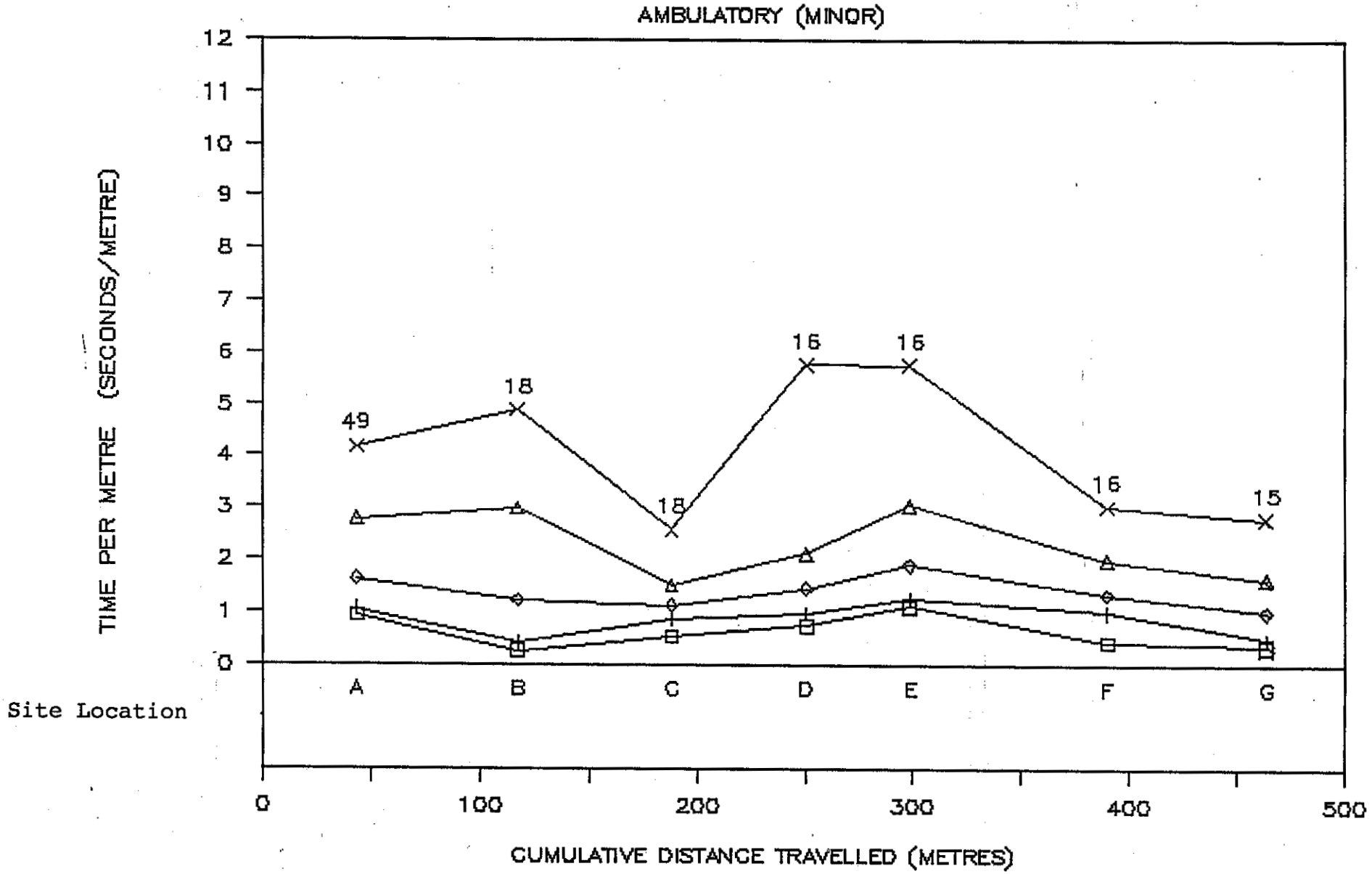


Fig 3.46

SLOWNESS RELATED TO DISTANCE TRAVELLED

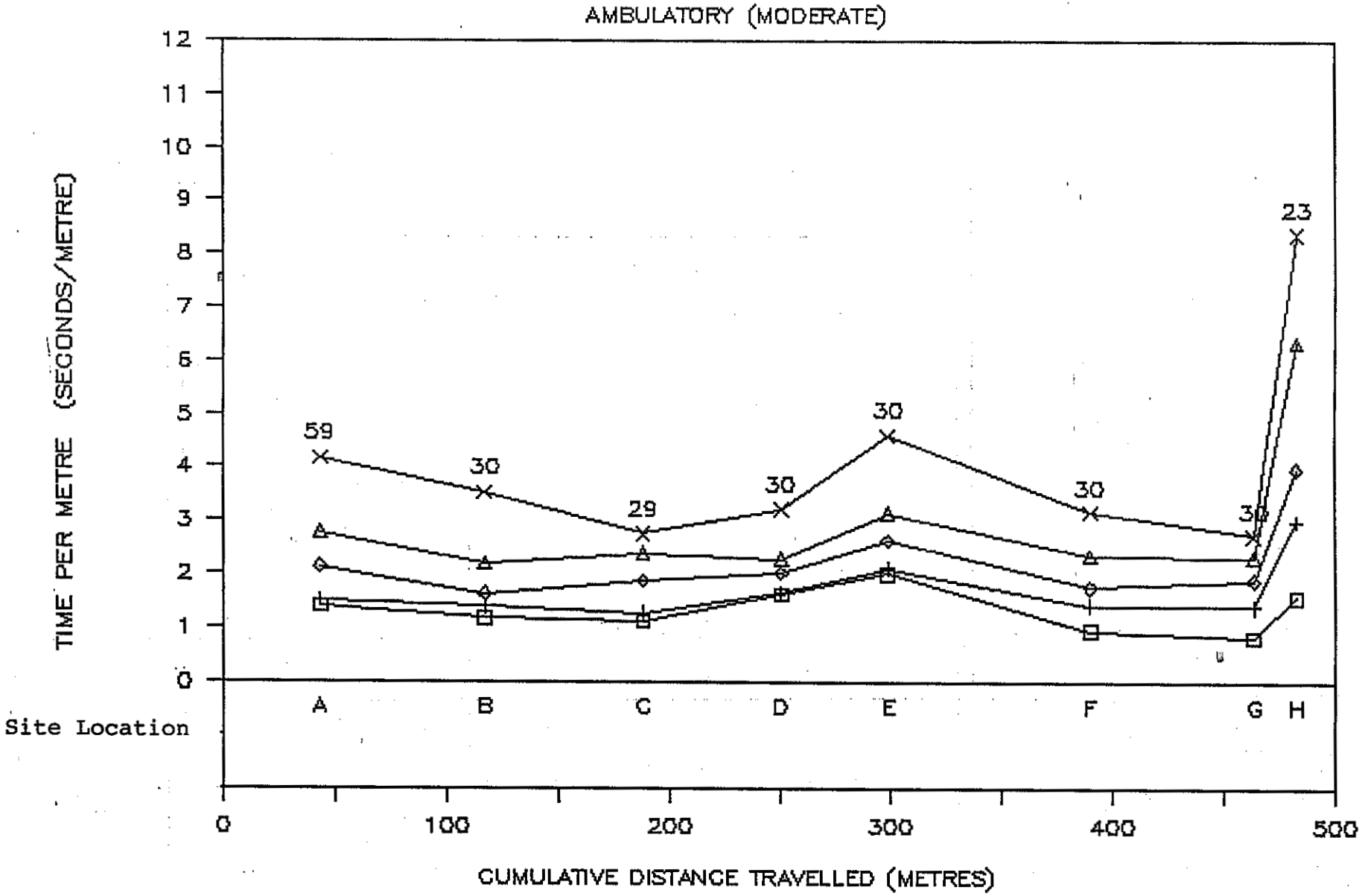


Fig 3.47

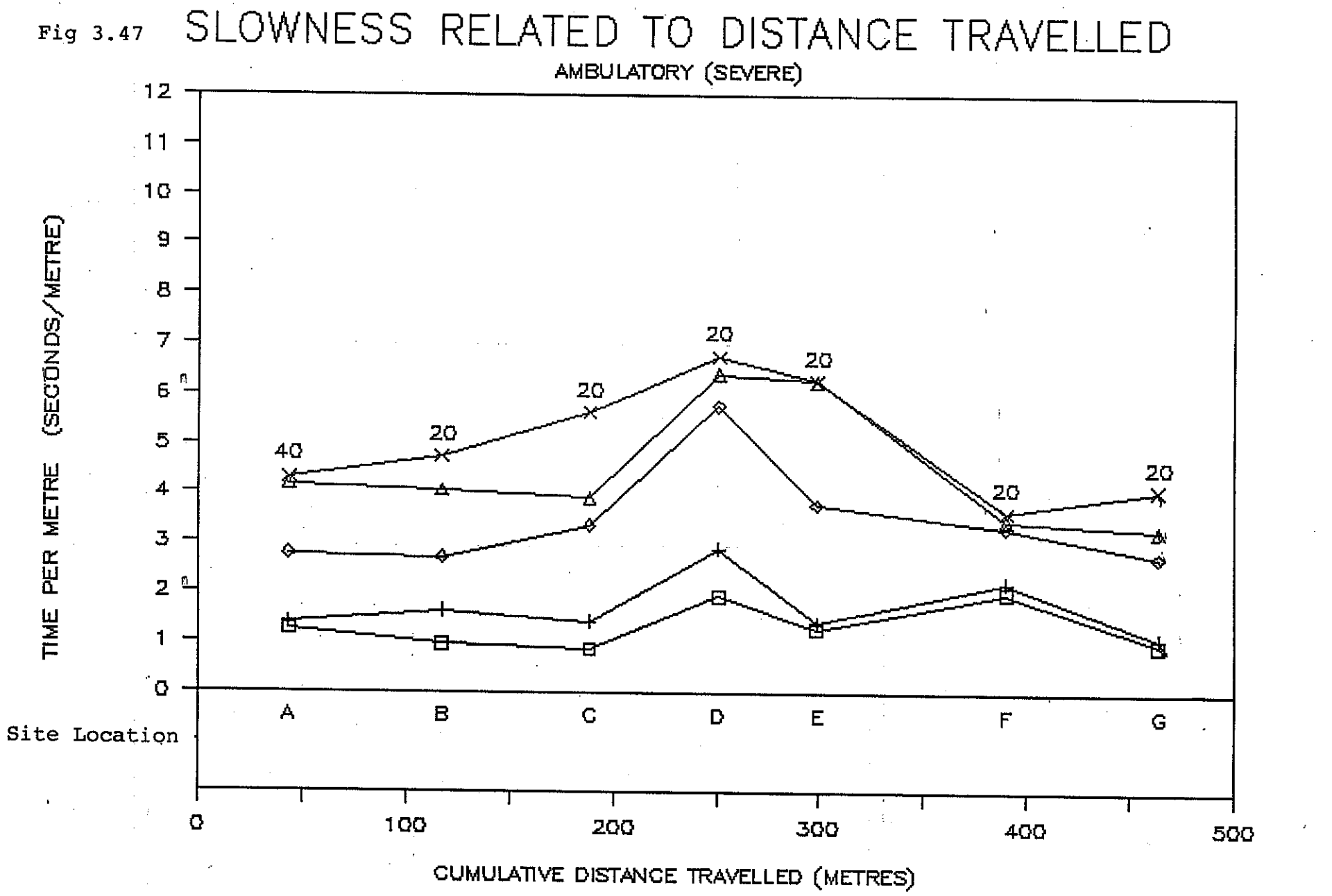

SLOWNESS RELATED TO DISTANCE TRAVELLED
AMBULATORY (SEVERE)
TIME PER METRE (SECONDS/METRE)
12
11
10
9
8
7
6
5
4
3
2
1
0
40
20
20
20
20
20
20
Site Location
A
B
C
D
E
F
G
0
100
200
300
400
500
CUMULATIVE DISTANCE TRAVELLED (METRES)
10th percentile
25th percentile
Median
75th percentile
90th percentile

Fig 3.48 SLOWNESS RELATED TO DISTANCE TRAVELLED

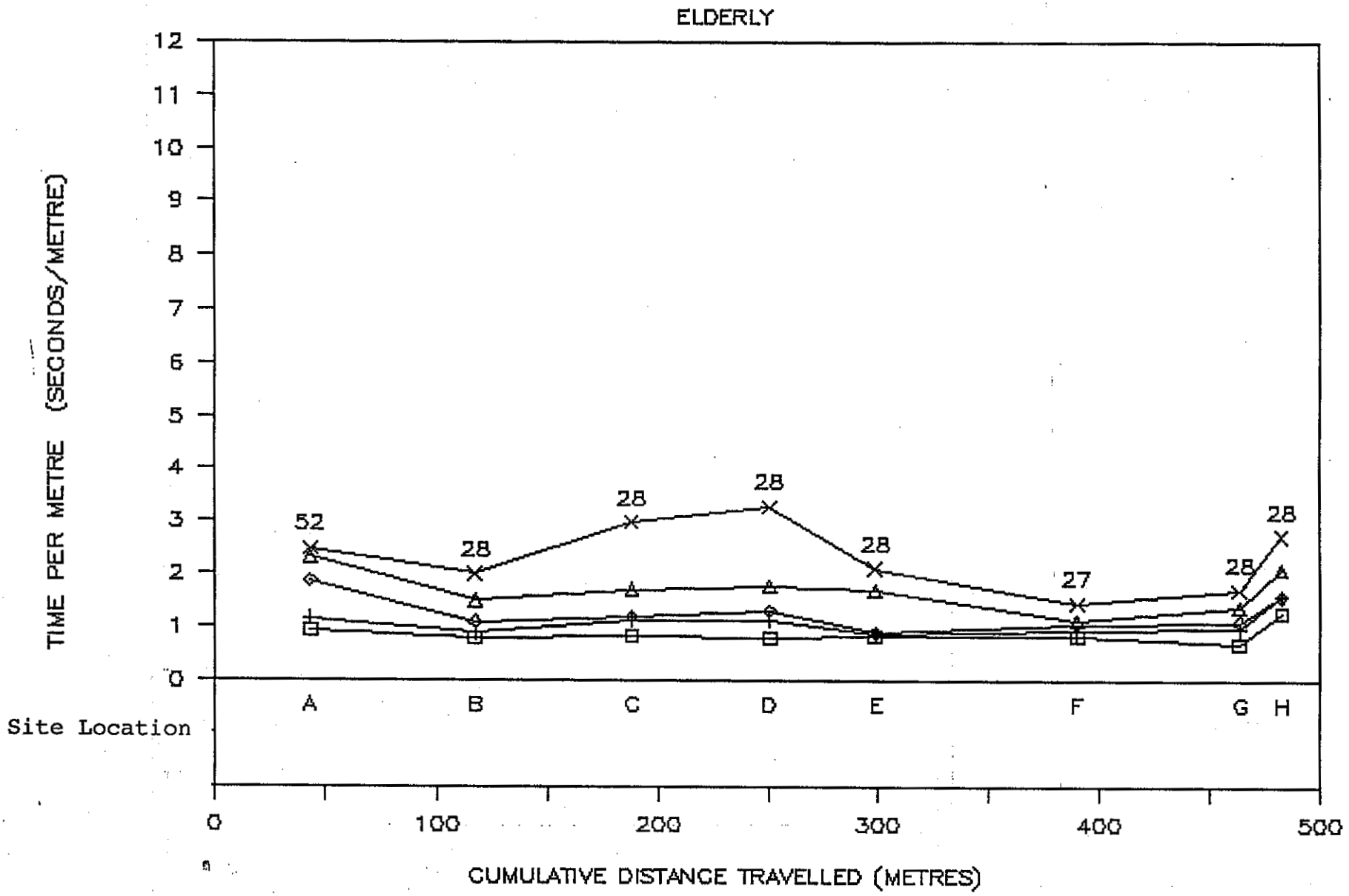


Fig 3.49 SLOWNESS RELATED TO DISTANCE TRAVELLED

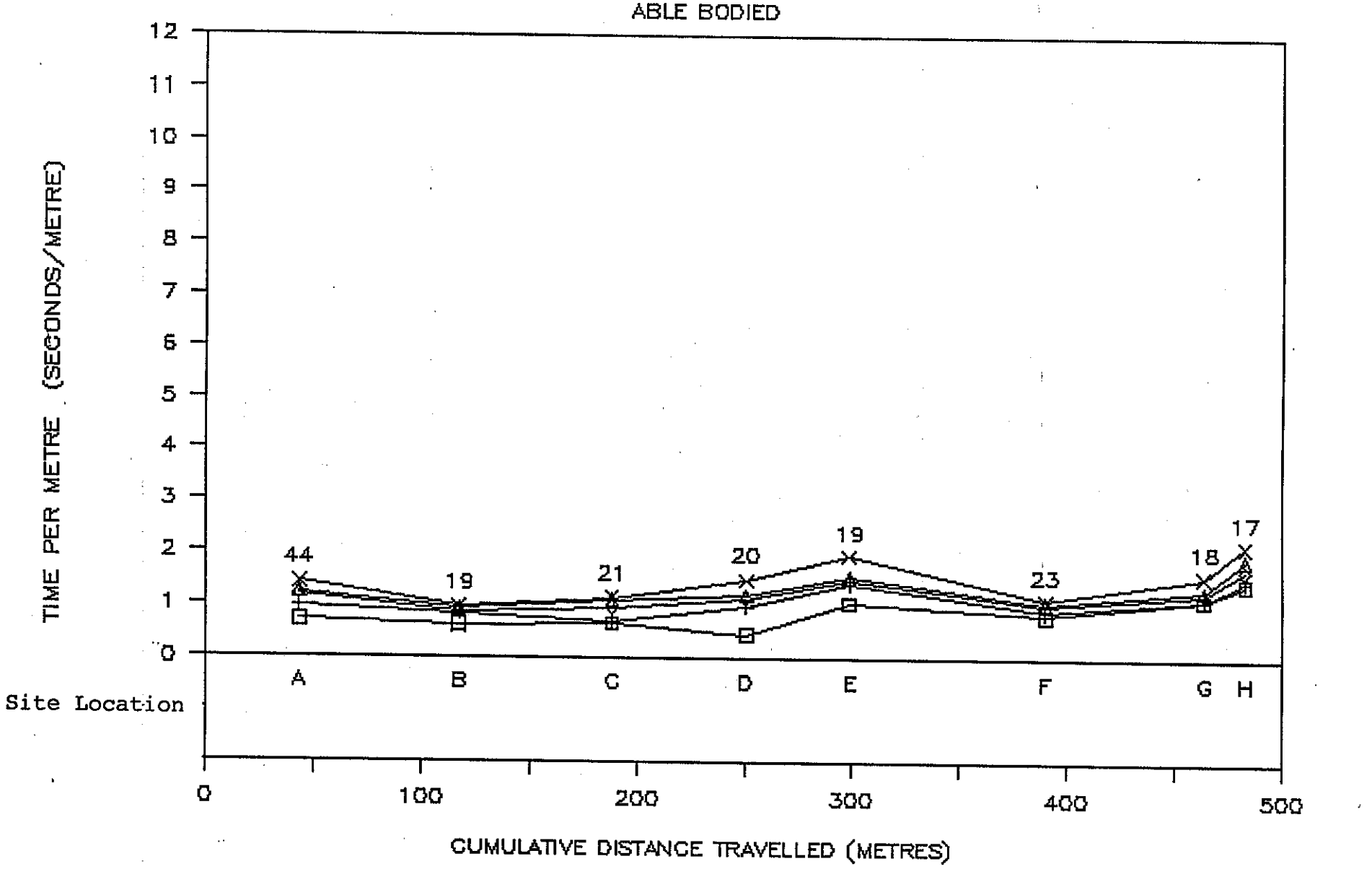


Fig 3.50 SLOWNESS RELATED TO DISTANCE TRAVELLED

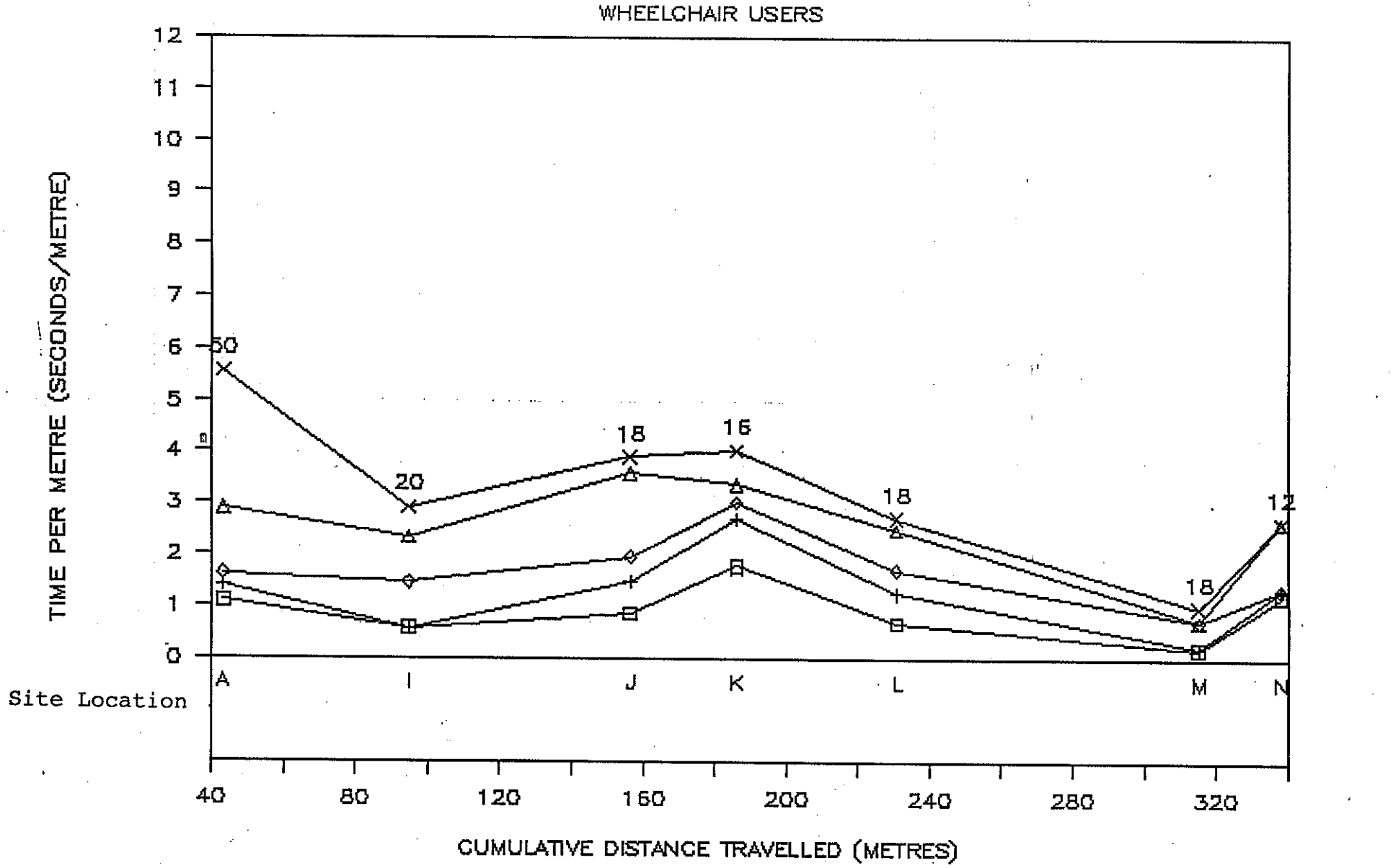


Fig 3.51

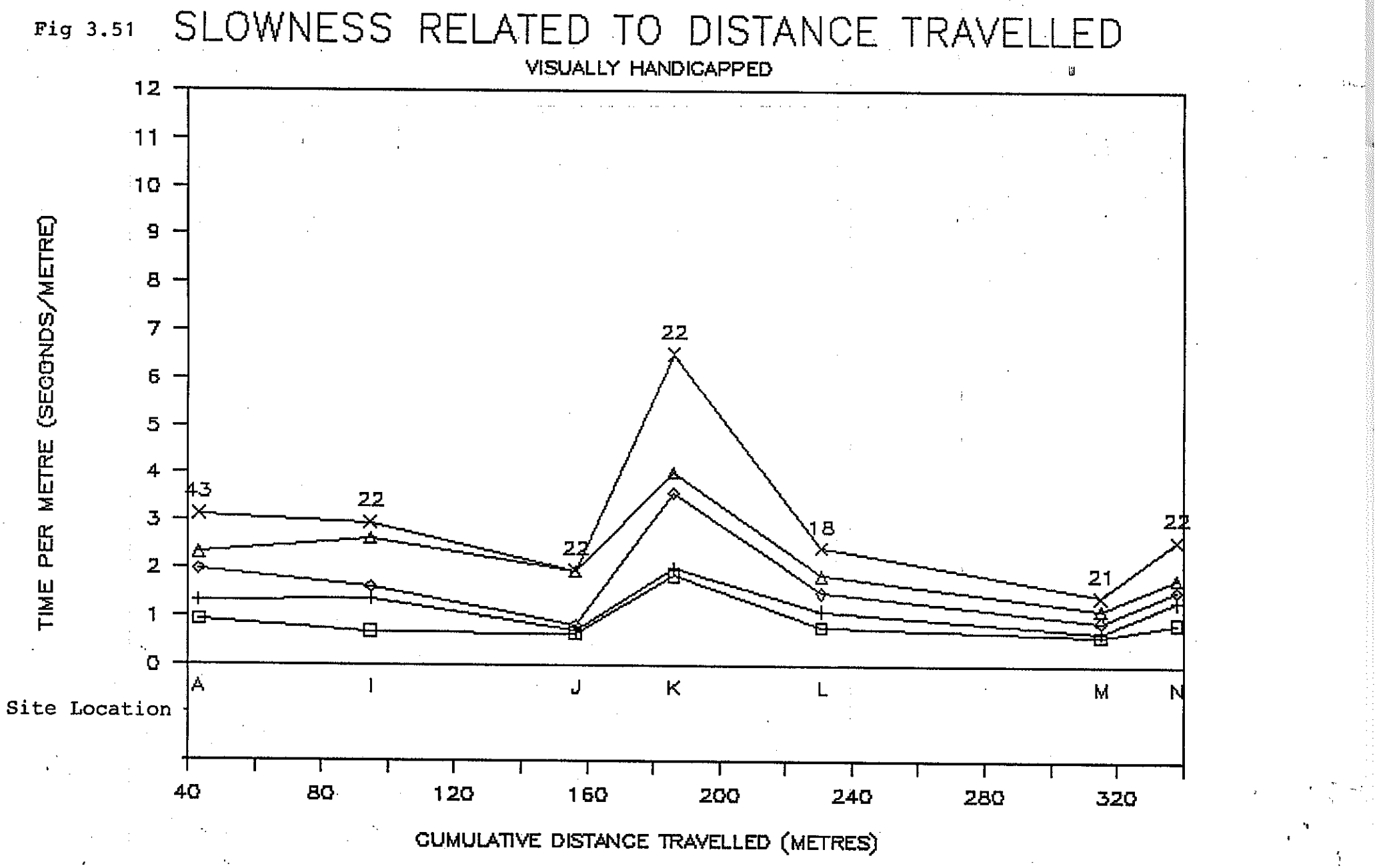

SLOWNESS RELATED TO DISTANCE TRAVELLED
VISUALLY HANDICAPPED
TIME PER METRE (SECONDS/METRE)
12
11
10
9
8
7
6
5
4
3
2
1
0
43
22
22
22
18
21
22
A
I
J
K
L
M
N
Site Location
40
80
120
160
200
240
280
320
CUMULATIVE DISTANCE TRAVELLED (METRES)
10th percentile
25th percentile
Median
75th percentile
90th percentile

Fig 3.52

SLOWNESS RELATED TO DISTANCE TRAVELLED

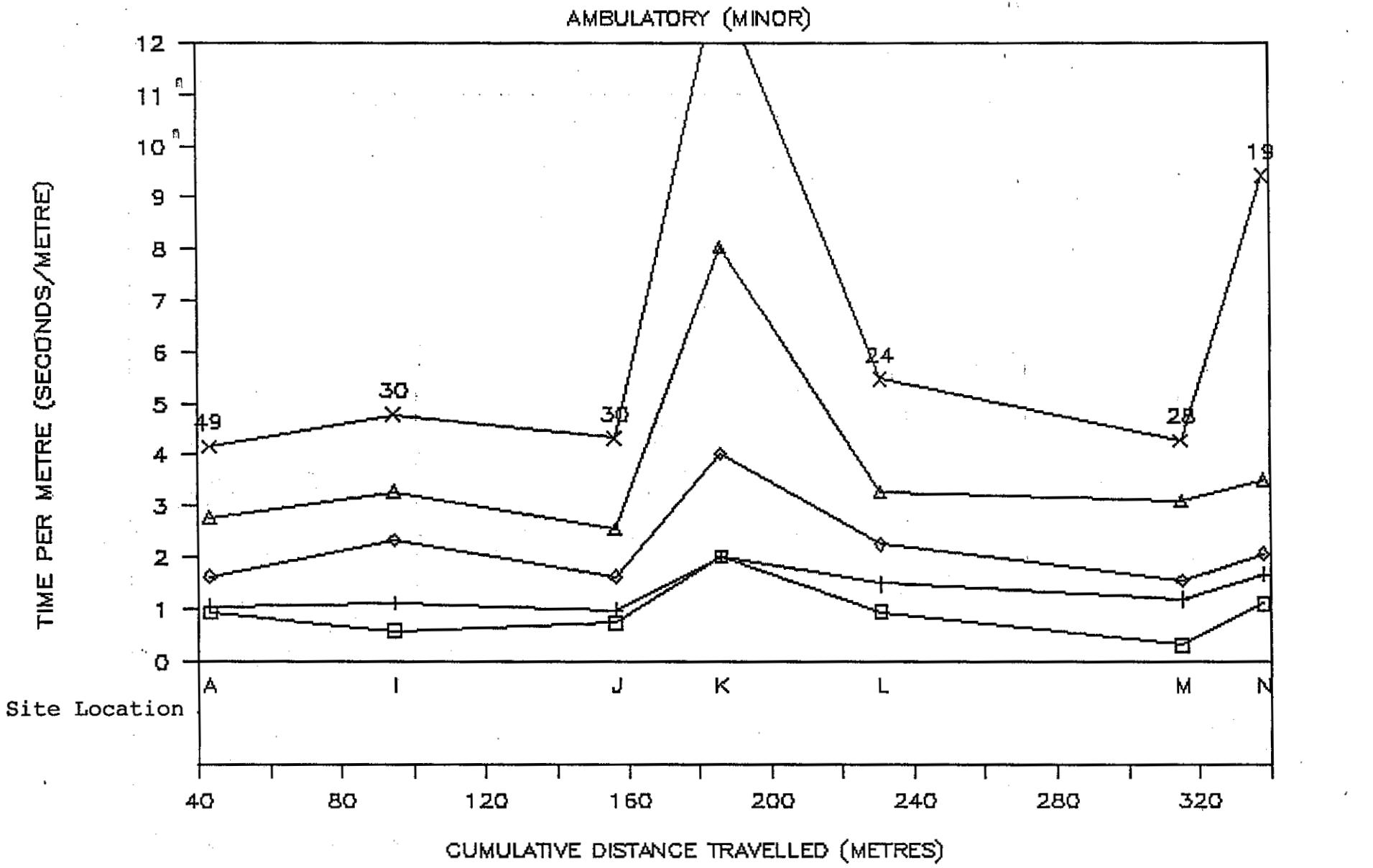


Fig 3.53

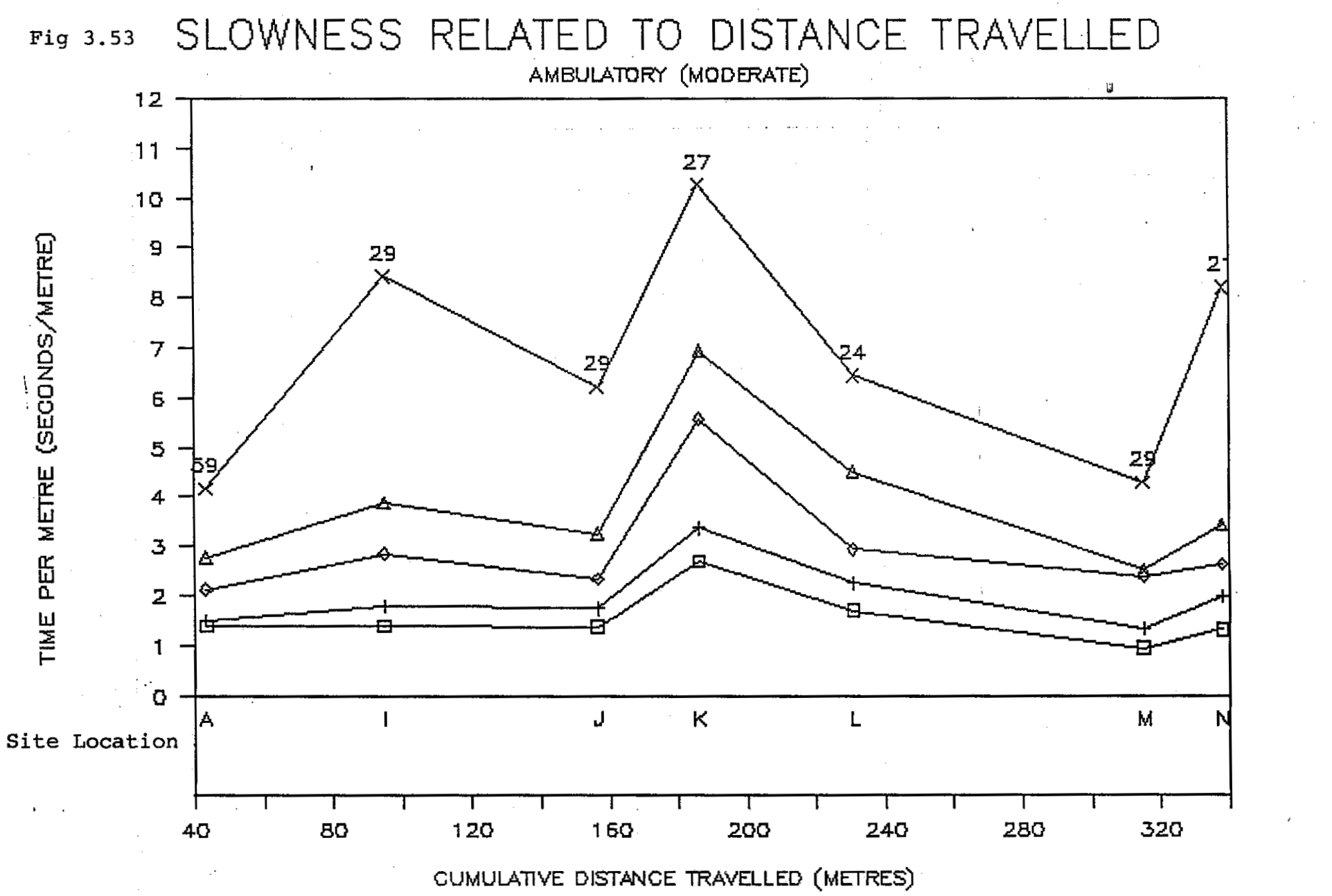

SLOWNESS RELATED TO DISTANCE TRAVELLED
AMBULATORY (MODERATE)
TIME PER METRE (SECONDS/METRE)
12
11
10
9
8
7
6
5
4
3
2
1
0
59
29
29
27
24
29
A
I
J
K
L
M
N
Site Location
40
80
120
160
200
240
280
320
CUMULATIVE DISTANCE TRAVELLED (METRES)
10th percentile
25th percentile
Median
75th percentile
90th percentile

Fig 3.54

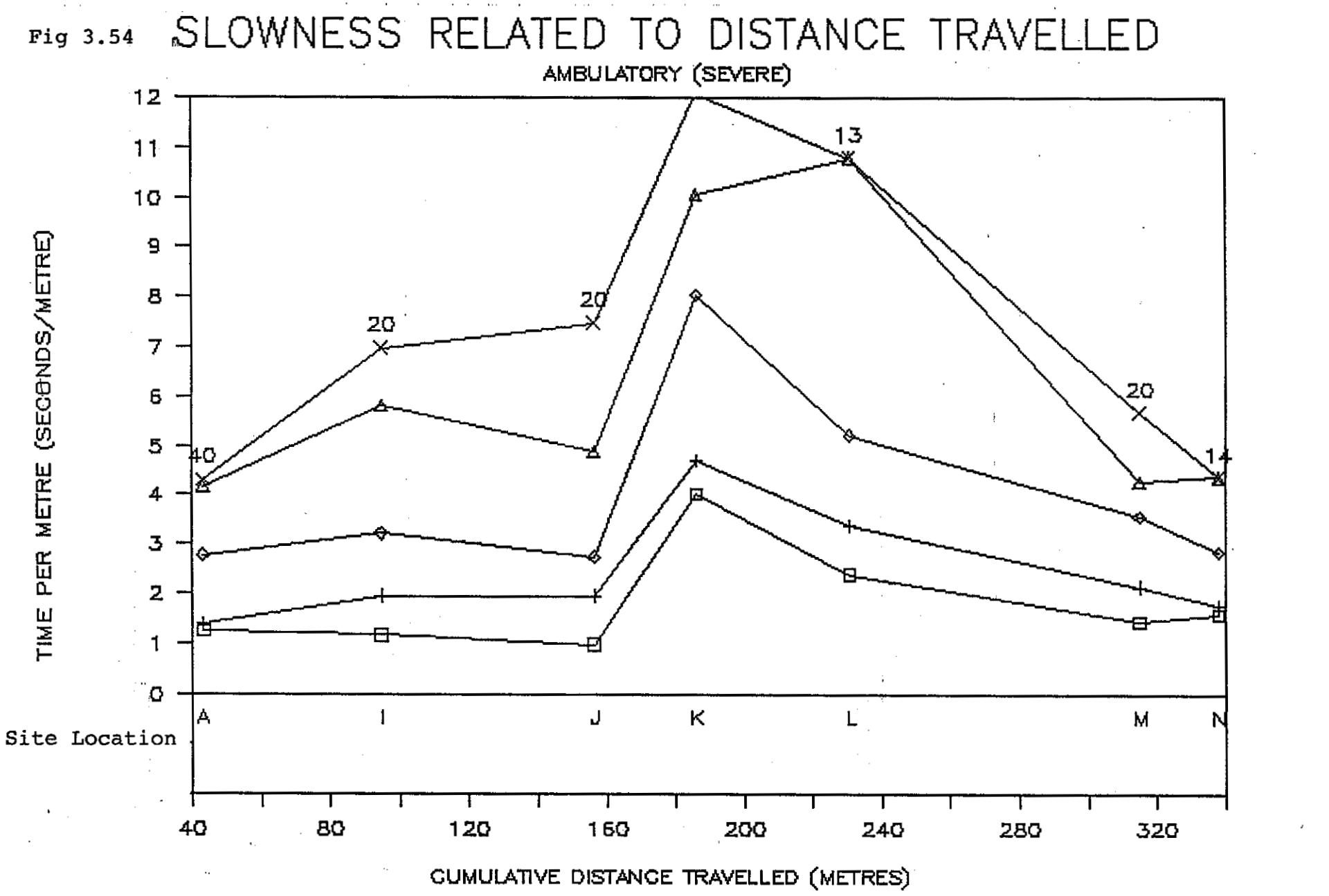

SLOWNESS RELATED TO DISTANCE TRAVELLED
AMBULATORY (SEVERE)
TIME PER METRE (SECONDS/METRE)
12
11
10
9
8
7
6
5
4
3
2
1
0
40
20
20
13
20
14
A
I
J
K
L
M
N
Site Location
40
80
120
160
200
240
280
320
CUMULATIVE DISTANCE TRAVELLED (METRES)
10th percentile
25th percentile
Median
75th percentile
90th percentile

Fig 3.55 SLOWNESS RELATED TO DISTANCE TRAVELLED

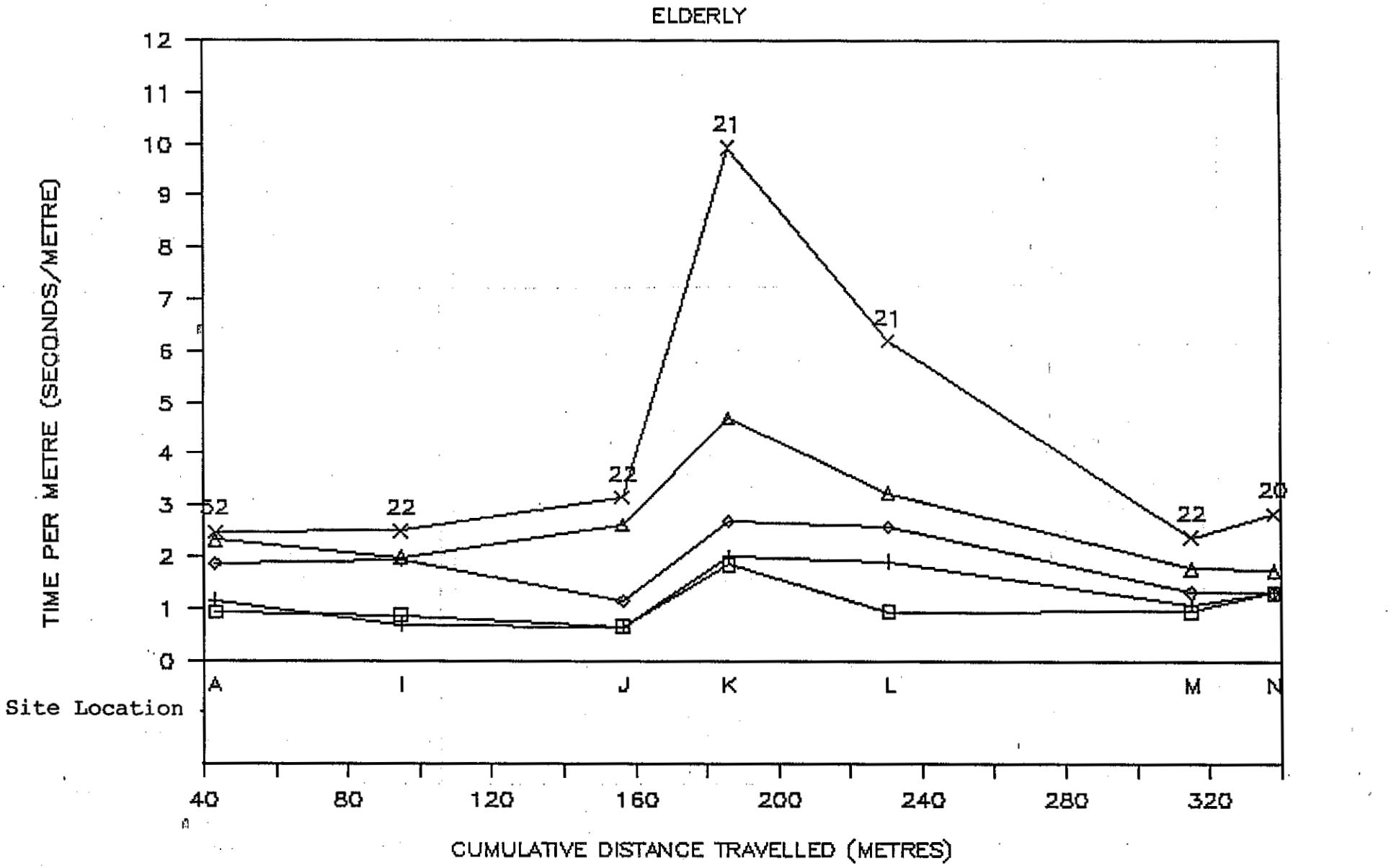
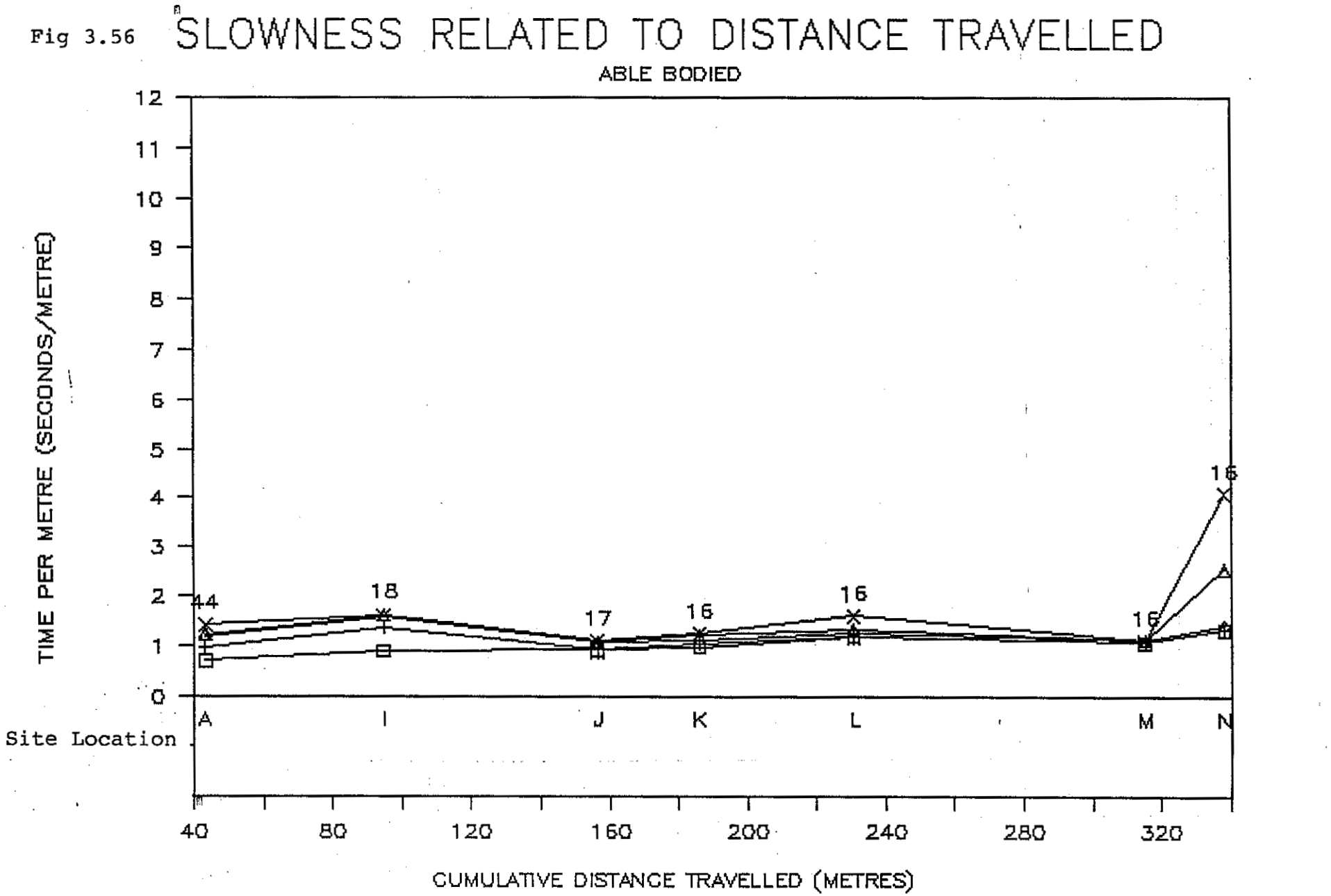


Fig 3.56


SLOWNESS RELATED TO DISTANCE TRAVELLED
ABLE BODIED
TIME PER METRE (SECONDS/METRE)
12
11
10
9
8
7
6
5
4
3
2
1
0
44
18
17
16
16
16
A
I
J
K
L
M
N
Site Location
40
80
120
160
200
240
280
320
CUMULATIVE DISTANCE TRAVELLED (METRES)
10th percentile
25th percentile
Median
75th percentile
90th percentile

3.9 Fatigue

The fatigue reported by respondents during the observation exercise was investigated in several ways.

Firstly, the numbers in a partiular disablility group stating that they were fatigued at the end of the first route section (by Saxone), were compared with those saying they were fatigued at the end of the last route section (by Chelsea Girl). From this comparison, the following conclusions were drawn:-

(a) For wheelchair users there was no significant difference in the proportion of participants reporting that they were fatigued;

(b) For the visually handicapped group there was a significant increase in fatigue;

(c) For all three ambulatory disabled groups there was a significant decrease in fatigue;

(d) For the elderly group there was a significant increase in fatigue;

(e) No incidence of fatigue was found in the able-bodied group at the beginning or end;

Secondly, pulse-rates were taken before and after the movement distance exercise for every participant. The increase in the pulse rate was about 5 on average. However, the answer that participants gave to the question:

> "Do you feel that you have made any abnormal demands upon your stamina or endurance by moving along this particular route?"

could not be correlated with the changes in pulse rates.

Thirdly, the age of participants was compared to whether fatigue was reported at the end of the movement distance exercise, but no significant differences were found.

Fourthly, for each section, the time taken by participants who reported fatigue was compared to the time taken by participants who did not report fatigue, but no significant differences were found.

3.10 Comparison of Site Characteristics and Disability Groups

The relative difficulties experienced by the various disability groups with the various site characteristics were compared visually. The rankings of disability types for each impediment type are set out below.

	Gaps between Pavers	Height Displacement	Camber	Slope	Grip
Most difficulty found	W'chair	W'chair	W'chair	W'chair	W'chair
:	Amb (sev)	Amb (sev)	Amb (sev)	Amb (sev)	Amb (sev)
:	Amb (mod)	Vis H'cpd	Amb (mod)	Amb (mod)	Amb (mod)
:	Amb (min)	Amb (mod)	Amb (min)	Amb (min)	Amb (min)
:	Vis H'cpd	Amb (min)	Vis H'cpd	Vis H'cpd	Vis H'cpd
Least difficulty found	Elderly	Elderly	Elderly	Elderly	Elderly
	Able B	Able B	Able B	Able B	Able B

The difficulty each disability group found with each site characteristic was also compared visually. As it was found difficult to rank the site characteristics, they were banded together into groups of site characteristics giving most difficulty for the relevant disability type, and site characteristics giving least difficulty. The results are set out below.

	Gap	Height	Camber	Slope	Grip	
Wheelchair	*	*	*	*	0	
Vis H'cpd	*	*	0		0	
Amb (severe)	*					* most
(mod)	*	0	0		0	difficult
(min)	*			*		
Elderly	*	*	0		0	0 least
Able-bodied	*		0	0	0	difficult

Gaps between pavers caused the greatest difficulty for all groups of disability, including the able-bodied group. The least difficulty was associated with surface friction and camber.

Wheelchair users, however, found approximately equal difficulty with all site characteristics except grip, where less difficulty was reported.

Wheelchair users and the ambulatory (severe) group consistently reported the highest levels of difficulty for each individual site characteristic. The elderly and able-bodied consistently reported the least difficulty.

After the elderly and able-bodied groups, the visually handicapped group recorded the next least difficulty for all site characteristics, with the exception of the characteristic relating to height displacements between pavers, where as much difficulty was found with height displacements as with gaps

between pavers.

An interesting finding was the relatively high levels of reported difficulty associated with gaps between pavers for the able-bodied group.

3.11 Inter-Site Comparisons

It was considered possible that respondents were tending to give overall assessments of sites (see Appendix A for details), rather than assessments of individual site characteristics. This was thought to be particularly the case where a site was regularly given a poor rating in comparison to what might be expected, based on the objective site characteristic measurements.

This was investigated by finding the sites most frequently mentioned as causing at least some difficulty by all respondent groups for all of the site characteristics.

The sites most frequently mentioned were found by identifying the four sites causing the most difficulty for each site characteristic and for each disability group, and then adding up the number of times each site occured.

Taken together, site G was among the worst 4 sites 20 times;
" N " 18 "
" K " 17 "
" C " 16 "
" H " 15 "

The worst sites overall, measured objectively, would be expected to be sites E, L, N, D, K. (This was found by taking the worst four sites as given by the measurements of camber, grip, height [by the plane method], slope, gaps, and totalling up the number of times each site was amongst the worst four.)

Sites K and N are in both lists of the worst sites.

Sites G, C, and H are given a poorer rating by participants than would be expected.

Sites E, L, and D are not rated as bad as would be expected based on the results of the objective measurements.

Sites G, C, and H were amongst the worst rated 4 of 14 sites 15 or more times out of a total possible of 35 times. The probability of this occuring by chance is less than 1 in 50 if it is assumed that these sites taken overall are no worse than other sites so it may be concluded that there is a characteristic of the sites that sets them apart from the others.

There appears to be little in common amongst these sites to explain why these sites should have been so poorly rated by respondents. It must be considered that the reason relates to either an inadequate method of measuring the site characteristics already observed, the presence of some site characteristic(s) that has not yet been considered, or the effect of a combination of site characteristics.

3.12 Video

The aim of the video recordings was to provide a means by which participants' movements during the movement distance and surface conditions could be recorded, and analysed at a later date. It has not been possible to conduct such an analysis because

* many of the participants appeared only briefly on the video and at different parts of the route.

* it was not always clear whereabouts on the route the participants were being videoed.

* the video recordings sometimes lacked the quality required for the purpose.

Useful lessons have been learned from this exercise:

* clearer results would be achieved if the camera were to be held stationary, rather than following individual participants, even if this means filming participants over a part of the route, rather than the whole route.

* the video recording needs to be of the front view of the participant

* there is extreme difficulty in recording both the facial expression of participants, and bodily movement simultaneously.

4. CONCLUDING COMMENTS

The method employed to observe how a sample of disabled people cope with the various impediments was generally satisfactory, although it was found that improvements could be made to parts of the methods.

The video work was hampered by the intrusion of the experimental technique into the behaviour of the participants. The difficulties of recording, without intrusion, the amount of detail that would be required in order to conduct meaningful analysis of participants' fatigue with the available resources of equipment and skills were not overcome and a new approach needs to be found for making such recordings.

The objective measurement of site characteristics revealed some unexpected complexities:

Surface friction measurement was obstructed by the non-availability of suitable equipment to take measurements over the correct speeds. Determining whether in fact a dynamic or static friction measurement is appropriate is a matter unresolved in literature reviewed.

Measurement of individual gaps was not difficult. There was some indication that it would be more appropriate to select a smaller minimum width; and the means of interpreting the number of different sized and oriented gaps could be improved.

The measurement of undulation by the plane method seemed to be successful, given that a relationship between objective measurement and participants' assessments was shown. Following the field work there was discussion on the possibility that a smaller grid would yield more accurate results as it would pick up better the undulations that can occur between one pace and the next, rather than overall changes in slope.

The measurement of camber, based on the 5m * 2m rectangular grids, may have been improved by instead taking more samples of camber along the whole length of the route section.

The measurement of slope by clinometer appeared to be satisfactory, but it is apparent from comments received informally that the length of a slope, as well as its gradient, can have an impact on participants' rating of difficulties found.

The graphical presentation of results appears to be successful as a means of representing the wide range of difficulties encountered by participants in coping with each of the route sections, and the comparisons of site characteristics and disability groups given in 3.10 gives a useful summary of results.

The results reveal varying strengths of relationship between measurements of heights, gaps, surface friction, camber and participants' assessments of these characteristics. It would not

be expected that the relationships would be exact because of the inherent difficulties in conducting trials in the field, rather than in laboratory conditions where extraneous variables can be limited. However, the advantage field work has over laboratory work is in its greater validity - it represents well the complexities of the real world and indicates the importance of judgement in setting standards.

References

Road Research Laboratory Ministry of Transport (1969) Road Note 27 Instructions for Using the Portable Skid-resistance Tester HMSO.

Berrett B, Leake G, May A D, Whelan J (1988a) Ergonomic Standards for Pedestrian Areas For Disabled People: Literature Review and Consultations. WP 252 Institute for Transport Studies, University of Leeds.

Berrett B, Leake G, May A D, Whelan J (1988b) Ergonomic Standards for Pedestrian Areas For Disabled People: Methodology and Sample Identification. WP 253 Institute for Transport Studies, University of Leeds.

Berrett B, Leake G, May A D, Parry T, Whelan J (1988c) Ergonomic Standards for Pedestrian Areas For Disabled People: Results of The Initial and Main Interviews. WP 254 Institute for Transport Studies, University of Leeds.

Appendix A

ROUTE SECTION CHARACTERISTICS

NUMBER OF HEIGHTS AND GAPS FOUND OVER THE ROUTE SECTIONS

Route Section Identity	Length m.	Heights mm 5-10	10-15	15-20	20-25	> 25	Total	Height per m m.	Gaps mm Longt 20-30	30-40	< 40	Transv 20-30	30-40	> 40	Total	Gaps per m m.
A Merrie England-Saxonne	43.2	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0.046
B Saxonne - C & A	73.9	1	0	0	0	0	1	0.0135	0	0	0	0	0	0	0	0
C C & A - Boar Lane	71.1	4	3	0	0	0	7	0.0985	2	0	0	2	0	0	4	0.056
D Boar Lane - BHS	62.5	1	0	0	0	0	1	0.016	2	0	1	1	0	1	5	0.08
E BHS - E Jones	47.8	3	1	0	0	0	4	0.0837	0	0	0	0	4	0	4	0.0837
F E Jones - M & S	91.1	2	0	0	0	0	2	0.022	0	0	0	0	0	0	0	0
G M & S - Fountain	73.8	3	0	0	0	0	3	0.0407	0	0	0	3	0	0	3	0.041
H Fountain - Chelsea Girl	19.2	1	0	0	0	0	1	0.0521	1	0	0	0	0	0	1	0.052
I Saxonne - Young Ones	51.6	2	0	0	0	0	2	0.0388	0	0	0	0	0	0	0	0
J Young Ones - DER	61.5	1	0	0	0	0	1	0.0163	0	0	1	0	0	0	1	0.016
K DER - BRIT	29.8	3	1	0	0	0	4	0.134	1	0	0	1	0	0	2	0.0671
L BRIT - A Reed	46.5	4	0	0	0	0	4	0.0899	0	0	0	3	0	0	3	0.0674
M A Reed - Smiths	84.4	0	0	0	0	0	0		0	0	0	0	0	0	0	0
N Smiths - Chelsea Girl	22.9	2	2	0	0	0	4	0.1747	0	0	0	1	1	0	2	0.0873
O Chelsea Girl - Queens Arcade	63.0	2	4	0	0	0	6	0.0952	2	0	0	0	0	0	2	0.0317
P Queens Arcade	75.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Q Bottom of Queens - Albion Place	50.3	3	0	0	0	0	3	0.0596	0	0	0	3	0	0	3	0.0596
R Albion Place	76.5	11	0	0	0	0	11	0.1438	0	0	0	1	2	0	3	0.0392

Appendix A

Route Section Characteristics (contd)

Angle of Inclination of Parts Of Route Section

Route Section Identity		First Part of Route Section		Second Part of Route Section		Third Part of Route Section		Gradient (%)
		Angle of Inclination	Length m.	Angle of Inclination	Length m.	Angle of Inclination	Length m.	
A	Merrie England-Saxonne	0	10.8	3	32.4			5.2
B	Saxonne - C & A	0	19	-4.5	54.9			- 7.9
C	C & A - Boar Lane	0	71					0
D	Boar Lane - BHS	2.5	62.5					4.4
E	BHS - E Jones	0	4.2	4	23.7	0	19.9	7.0
F	E Jones - M & S	- 2	17.2	0	73.9			- 3.5
G	M & S - Fountain	0	7.8	3	66			5.2
H	Fountain - Chelsea Girl	1.5	19.2					2.6
I	Saxonne - Young Ones	0	51.6					0
J	Young Ones - DER	2.5	15.4	0	27.9	5	18.2	8.7
K	DER - BRIT	1.5	29.8					2.6
L	BRIT - A Reed	2.5	44.5					4.4
M	A Reed - Smiths	0	33.6	- 1	50.8			- 1.7
N	Smiths - Chelsea Girl	0.5	22.9					0.8
O	Chelsea Girl - Queens Arcade	2	63.0					3.5
P	Queens Arcade	-3	75.3					- 5.2
Q	Bottom of Queens-Albion Place	-1.5	50.3					2.6
R	Albion Place	2.5	76.5					4.4

Note: underlined part of route section is the steepest part of route section, and is used in the analysis.

Appendix A Route Section Characteristics (contd) FRICTION

Route Section Identity		Mean Friction of Two Sets of Readings*	Type of Material in Principal Use on Route Section
A	Merrie England-Saxonne	**	Yellow Brick Pavers
B	Saxonne - C & A	43	Concrete Paving Slab
C	C & A - Boar Lane	49	" " "
D	Boar Lane - BHS	44	" " "
E	BHS - E Jones	22	Yellow Brick Pavers
F	E Jones - M & S	16	" " "
G	M & S - Fountain	51	Concrete Paving Slab
H	Fountain - Chelsea Girl	50	" " "
I	Saxonne - Young Ones	16	Yellow Brick Pavers
J	Young Ones - DER	53	Concrete Paving Slab
K	DER - BRIT	43	" " "
L	BRIT - A Reed	31	" " "
M	A Reed - Smiths	41	" " "
N	Smiths - Chelsea Girl	49	Red Road Brick Pavers
O	Chelsea Girl - Queens Arcade	49	Concrete Paving Slab
P	Queens Arcade	23	Smooth Marble Chip
Q	Bottom of Queens - Albion Place	46	Concrete Paving Slab
R	Albion Place	50	" " "

* Corrected for temperature.

** Surface re-laid between field trials with participants and the measurement of surface friction.

Temperature of water on road varied between 13 - 14.5 C.

Appendix A Route Section Characteristics (contd) CAMBER AND UNDULATION

	Route Section Identity	Camber: Mean difference in heights for nodes on long sides for sample sites (mm)	Camber: Mean camber over the two metre width (%)	Undulation: Mean absolute variation in height of each node from hypothetical plane for sample sites (mm)
A	Merrie England-Saxonne	5.5	.275	3.34
B	Saxonne - C & A	5	.25	6.1
C	C & A - Boar Lane	42.5	2.1	6.63
D	Boar Lane - BHS	57	2.85	5.45
E	BHS - E Jones	2	.1	2.57
F	E Jones - M & S	4	.2	1.68
G	M & S - Fountain	31	1.55	2.87
H	Fountain - Chelsea Girl	23.5	1.175	11.64
I	Saxonne - Young Ones	5	.25	1.68
J	Young Ones - DER	28.5	1.425	5.4
K	DER - BRIT.	25	1.25	10.95
L	BRIT - A Reed	20	1	7.58
M	A Reed - Smiths	113	5.65	6.79
N	Smiths - Chelsea Girl	102.5	5.125	8.59

Appendix B
PARTICIPANTS FATIGUE

No of participants saying they were fatigued at the end of each section of route

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	H+N
Wheelchair user															
Fatigued	17	15	16	12	13	15	14	10	8	11	12	9	9	6	16
Not fatigued	25	13	13	15	15	13	13	11	10	6	3	7	7	4	5
Visually handicapped															
Fatigued	2	2	1	2	6	5	6	4	1	1	2	2	3	3	7
Not fatigued	33	20	20	18	15	16	15	14	16	16	15	14	14	14	28
Ambulatory (minor)															
Fatigued	30	9	8	9	7	6	4	2	19	18	19	13	16	11	13
Not fatigued	3	1	2	1	3	5	4	2	4	5	4	8	5	6	8
Ambulatory (moderate)															
Fatigued	38	22	20	21	19	19	16	12	15	19	15	13	14	9	21
Not fatigued	4	2	3	3	5	4	7	6	5	1	4	4	6	6	12
Ambulatory (severe)															
Fatigued	29	15	15	14	14	13	11	6	11	10	9	7	11	5	11
Not fatigued	2	3	3	2	2	3	3	1	4	5	5	2	4	6	7
Elderly															
Fatigued	1	1	1	2	2	5	7	7	2	3	3	4	5	5	12
Not fatigued	46	25	25	46	24	20	18	17	18	17	16	16	14	14	31
Able bodied	No results (no-one said fatigued)														

A - end of first route section H - end of long route N - end of short route

APPENDIX C LEEDS FIELD WORK ROUTE