CRANFIELD INSTITUTE OF TECHNOLOGY

SILSOE COLLEGE

M Phil THESIS

Academic Year 1986 - 88

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IMPROVEMENTS TO FURROW PRESS PERFORMANCE

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March 1989

This thesis is submitted for the degree Master of Philosophy

ABSTRACT

The objective of this project was to improve the performance of the furrow press, with particular regard to three applications :

i) consolidation in light land
ii) clod breaking in clay soils
iii) tilth production in medium soils

Work conducted by Ansell (1986) led to the suggestion that a press consisting of different diameter wheels on the same axle might satisfy some or all of these requirements.

This project began by studying the action of a press in two dimensions (horizontal-vertical plane) using short sections of press wheels in a glass sided soil tank. Different combinations and spacings were considered and their effectiveness measured by breaking clods in the soil. Different shaped sections were also tested, using loose soil to study the effect of shape on soil movement.

Following the two-dimensional testing, a range of different diameter press rings were tested in the Silsoe College Soil Bin. A number of diameter /spacing combinations were used, and each was evaluated at three different weight levels. The resulting soil profiles were measured, together with plate penetrometer tests as an indicator of soil density.

It was found that an excess of weight could cause a reduction in average soil strength by greatly reducing surface bulk density.

Using the combinations selected from the work in the soil bin a number of full width presses were tested on seven field sites, ranging from a very sandy loam to a wet clay loam. Profiles were measured before and after passing a tractor over the work. The sinkage was proportional to the soil strength. Photographs were taken and analysed to rank the treatments in terms of clod size reduction.

Evaluation of the field trials has led to the development of a composite press with a geometry and weight arrangement that has produced significant improvements in light land consolidation, clod size reduction and tilth production.

ACKNOWLEDGEMENTS

I would like to thank Mr M J Hann for his guidance throughout the project, together with Mr T Reynolds for his inspiration and Mr R Newland and Miss Z Morrison for their help in collecting and analysing data.

I am also deeply grateful to Hill and Osborne Ltd for sponsoring this project and providing the equipment used.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1 : INTRODUCTION

1.1. Use of the furrow press

The furrow press is a very old tillage implement. It usually consists of a number of heavy cast iron rings running on an axle and pulled behind the plough. There were traditionally two wheels per furrow, spacing being dependent upon the furrow width. With the introduction of mounted instead of trailed ploughs the use of a press declined.

The development of high yielding varieties of cereals in the 1970s began to create a timeliness problem. For maximum returns from these varieties, they must be drilled as soon as possible after harvest. In order to overcome this problem, a whole new technique of mimimum tillage, heavy use of chemicals and strawburning evolved. In the past few years, strawburning has become less acceptable, and it is now widely felt that it will become prohibited in the future. This has led farmers to return to the plough as a method of dealing with the increased surface trash. In the meantime, a simple linkage system had been developed to enable the furrow press to be used behind mounted reversible ploughs. Both these factors have led to a dramatic increase in the use of Furrow Presses over the past few years.

There are three main functions performed by a press :

i) Consolidation of the furrow slice
ii) Levelling the surface into small ridges and furrows
iii) A reduction in clod size

Depending upon the soil type, then the relative importance of these functions will change; on sandy soils, consolidation throughout the furrow slice is the most important whereas on clay soils, clod-breaking and consolidation of the large voids under the furrow slice would be of a greater importance.

Furrow press manufacturers cater for these different requirements by offering rings of different profiles. A narrow ring being recommended for heavy soils, and a broad ring for light soils.

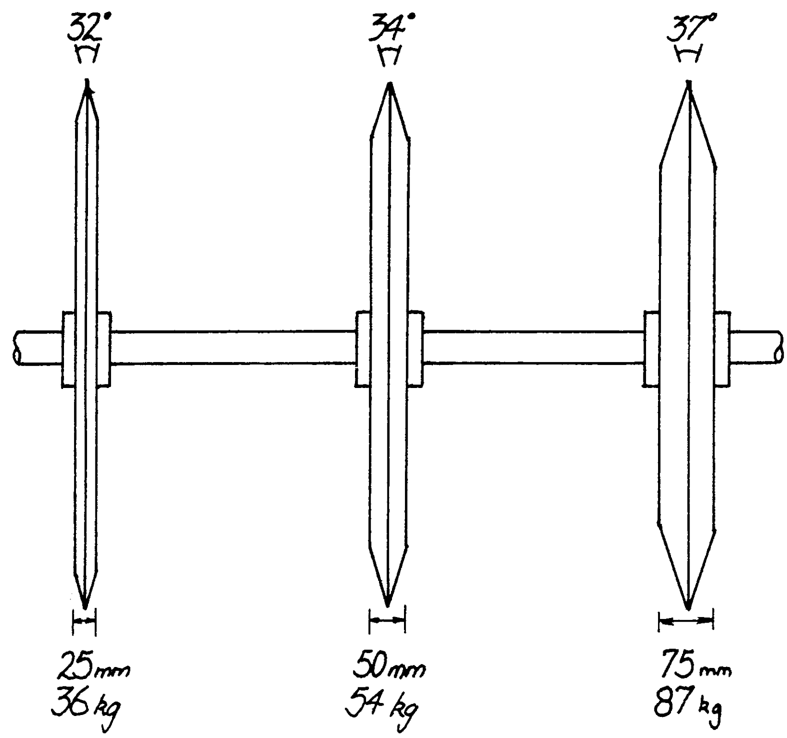


Fig 1.1.1 A range of typical furrow press rings

1.2 Lack of research

The furrow press is a tool which has evolved through the ages, its design changing slowly, mainly due to manufacturing methods or marketing gimmicks, rather than any understanding of the fundamental principles behind its action.

Relevant work was conducted by Culpin (1937) on the action of conventional rolls, and by Reece (1967) on steel wheels, but neither really cater for the specific application of a press wheel. Sanchez Giron-Renedo (1985) carried out the first work on furrow presses, and found that soil flowed forwards from the press, vertically upwards and downwards and sideways. There was still no real understanding of the actual mechanisms of soil flow beneath press wheels.

Ansell (1986) modelled the vertical and sideways movement using sections of a press wheel, lowered into a glass-fronted tank. Soil behaviour under single feet was studied, and then between pairs of feet at different spacings. The interaction between the two feet led to four types of failure pattern being described.

1.3 A composite press

It was found that under certain spacings considerable constraining forces were generated. Ansell (1986) felt that these could be used to improve clod breaking if a press consisting of rings of a different diameter were used. (Fig 1.3.1.) He did some two-dimensional work which suggested that such an arrangement showed great promise for improving the performance of furrow presses.

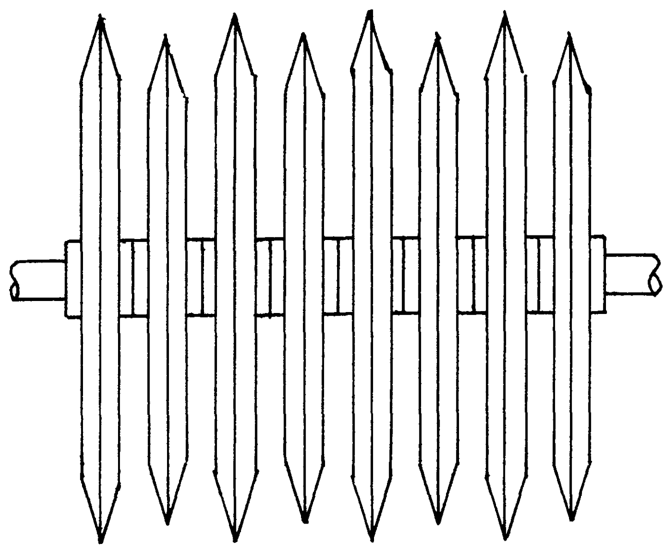


Fig 1.3.1. A composite press

1.4 Objectives

The objective of this project is to investigate methods of improving the performance of furrow presses, performance being measured as consolidation at depth, surface levelling and clod size reduction.

To reach this objective the following methodology was to be considered :

i) Further studies of the soil force system developed by a composite press (section 3)

ii) The effects of different ring profile on penetration (section 4)

iii) To develop a composite press and evaluate its performance under both soil bin (section 5) and field conditions (section 6)

iv) To evaluate the effects of speed on the performance of a press (section 7)

v) To assess the performance of angled gangs of furrow presses (section 8)

SECTION 2 : BACKGROUND AND LITERATURE REVIEW

2.1 Practical Background.

Despite the lack of scientific work published on the furrow press, there is no shortage of claimed benefits and information available from manufacturers literature; advantages often claimed are that :

- they save one cultivation pass by eliminating the need for rolling

- they compress the bottom two-thirds of the furrow slice and leave the top third crumbled

- they increase the moisture content at root depth by pressing out air pockets trapped within the inverted soil so that the natural capillary action of the soil moisture is improved

- they enable easier seedbed preparation because the ridges formed weather better

- the consolidation of the land means that at the time of the next pass there is less rolling resistance, and so a saving in fuel

Manufacturers commonly suggest :

- usual separation between wheels should be between 150-180mm

- wheels with a wide profile give the best results on light land

- wheels with a narrow profile give the best results on heavy land

- the sharper the profile and the greater the weight, the greater the penetration, and consolidation at depth

Field trials on heavy clay (Hann 1986) suggest that an increase in weight gives an improved result. Also if the soil is in a plastic state at ploughing then a delay of up to several days (depending on soil and weather conditions) will considerably improve performance. The soil must not however be allowed to dry too much or all the possible improvements may be lost

2.2 Existing Work

2.2.1 Sanchez - Giron Renedo (1985)

Three sets of furrow presses were tested at about 177mm separation in a loose sandy loam (moisture content 7% dry basis, bulk density = 1260kg/m^3). Soil movement was measured by placing lines of beads throughout the soil profiles and plotting their change in position.

His relevant conclusions were :

- under the action of a furrow press the soil is not only displaced forward and sideways, but also upward and downward

- a turbulent zone exists at the soil surface where the soil particles beneath the rings are moved downward and the ones midway between adjacent rings are moved upwards. Below 100mm depth the soil particles have a generalised downward movement

- at 200mm depth, practically no soil movement occurs

- compaction occurs in the soil sub-surface (100-200mm) whereas dilation, or no change occurs in the surface (1-100mm depth)

- not only weight per ring but also weight per width of ring rim and the ring profile are the main factors affecting the performance of the furrow press for a given separation

2.2.2 Dauda (1986)

Dauda continued the work of Sanchez (1985) who had concentrated on press arrangements as available from manufacturers, by looking at possible variations in standard press designs not currently available.

He monitored the effects of increasing weight, width and spacing as well as considering a range of included angles (30°, 60°, 90°). Soil disturbance was measured in the manner described by Sanchez (1985). The conclusions reached were generally similar to those of Sanchez but in addition he found :

- with the same geometry (included angle, diameter, width, spacing) increased weight gives greater sinkage and compaction.

- increased wheel spacing (other parameters constant) gives more penetration and compaction. There is however a limit to this effect, once each ring begins to act as an individual. When spacing is reduced there is a stage when the individual rings exhibit the characteristics of a single roller and compaction is limited to the top 50mm.

- the smaller the included angle the larger the degree of penetration and, hence, compaction at depth

- the draught force requirement of furrow presses increases with increased weight, ring spacing and width.

2.2.3 Ansell (1986)

Ansell concentrated his work on trying to achieve a better understanding of the mechanisms of soil failure beneath a two dimensional press. From the work of Renedo (1985), it had been established that although soil was displaced forwards, the majority of soil movement occurs in the vertical and sideways directions. A model of a furrow press was made using short sections of press wheels. These sections were lowered by means of a hydraulic ram into a glass-fronted soil bin. Soil movement could be monitored by means of chalk dots placed in a 20x20mm grid between the soil and the glass.

His first study was, however, concerned with the effect of time and drying on the failure of clay clods. This was conducted to try to discover whether an optimum time delay between ploughing and pressing existed. Two effects were found :

i) A time effect; as time increases, after approximately 30 minutes the failure mechanism changes from brittle to compressive, provided no drying occurs.

ii) A drying effect; the more that clods were dried, the more likely they were to fail in a brittle manner, caused mainly by a hard outer shell. After 9 hours drying, all the clods failed in a brittle manner.

The implications of this work are that there can be no fixed guideline for the plough-press delay, as the failure pattern is totally dependent on the drying conditions.

Using the 2-dimensional model, work was conducted, using both single and pairs of feet. There were three sections of press; narrow, medium and wide, the first two being replicas of existing rings, and the other being a new design (fig 2.2.1)

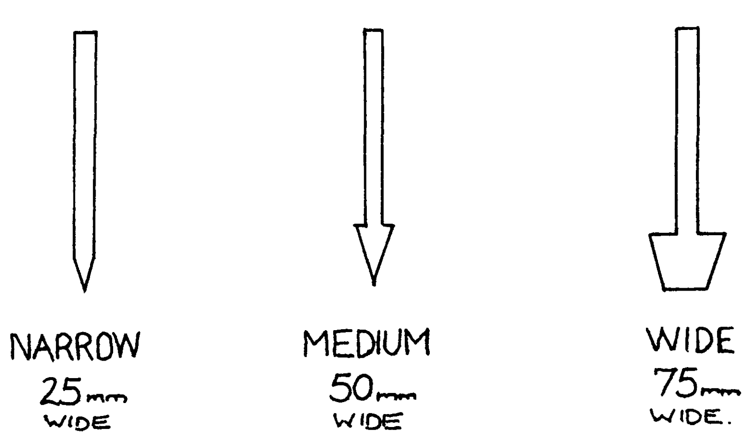


Fig 2.2.1 Press sections used for 2-Dimensional Modelling

Three types of soil failure were observed, and each fitted an existing soil failure theory.

i) Wide Foot - An active triangular soil wedge was formed directly under the foot either side of the wedge zones of passive failure, definite slip planes were formed. This is a typical bearing capacity failure (Fig 2.2.2i)

ii) Medium Foot - The observed failure was similar to that proposed by Meyerhoff (1981) for soil failure under a shallow rough wedge. Slip planes emanated from the tip of the wedge causing zones of passive failure either side of the wedge. There was also a zone of compressive failure under the wedge (Fig 2.2.2ii)

iii) Narrow Foot - The observed failure was similar to that suggested by Meyerhoff for failure under a deep rough wedge. There were no well defined slip planes along which slip was occuring. The failure was compressive with soil flow away from the wedge (Fig 2.2.2iii)

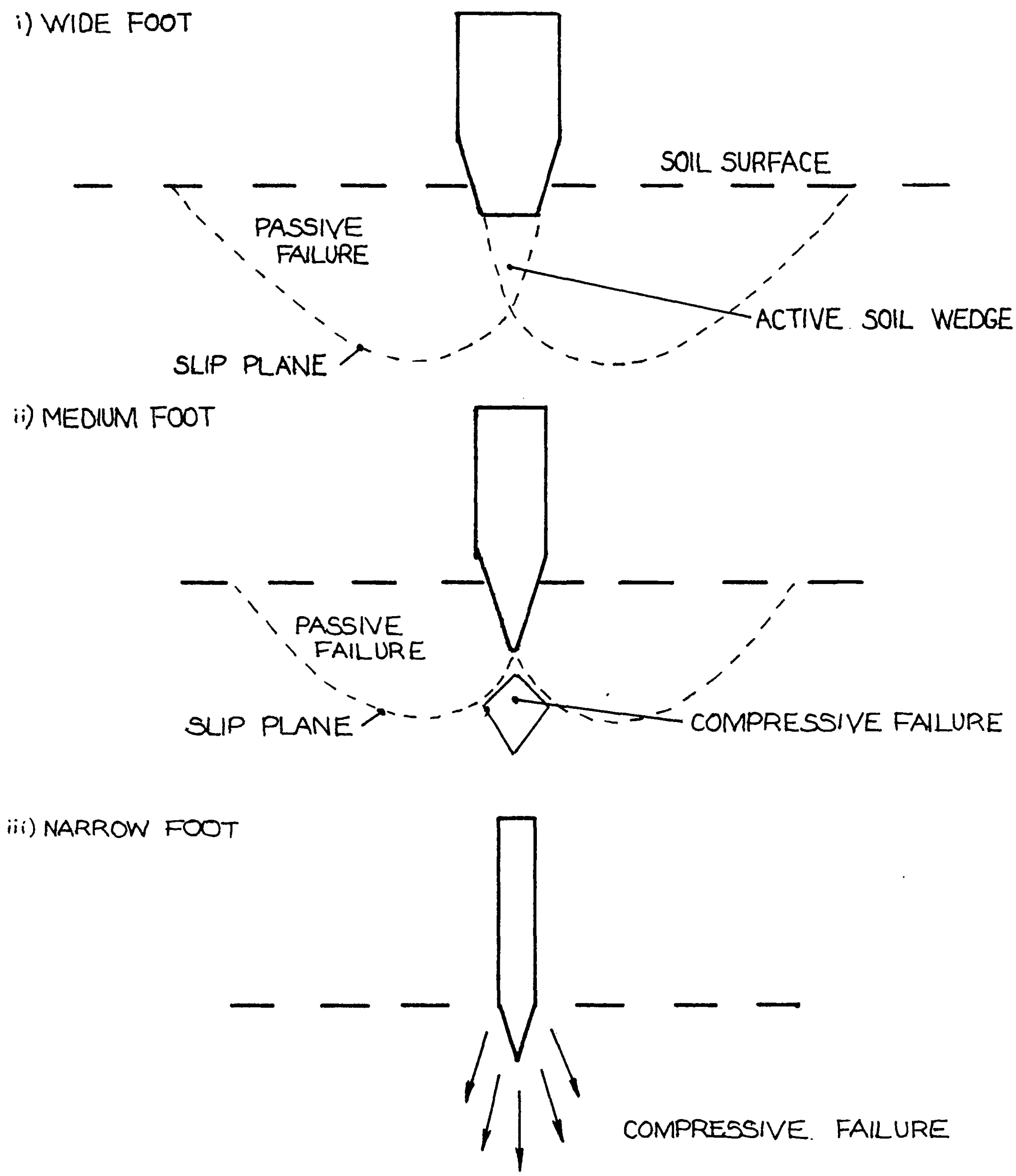


Fig 2.2.2 Soil Failure Patterns under a single press section

Work carried out using pairs of medium feet demonstrated four distinct failure types (Fig 2.2.3)

i) At a separation of 610mm, there was no interference between failure zones. This action can be described as independent passive failure, with mainly horizontal soil flow (Fig 2.2.3i)

ii) With a narrower separation (350mm), horizontal soil flow away from each foot met in the middle producing opposing flow. There was no vertical soil movement between the feet at any depth. This is known as interacting passive failure zones (Fig 2.2.3ii)

iii) At separations between 267mm and 133mm, not only is there horizontal flow, but vertical soil movement, both upwards and downwards. This soil flow is around a diamond shaped active zone, in which no soil movement occurs. As the separation reduced, the diamond was found to rise to the surface (Fig 2.2.3iii)

iv) At a spacing of 89mm a diamond zone was no longer found, and a purely compressive failure was found (Fig 2.2.3.iv).

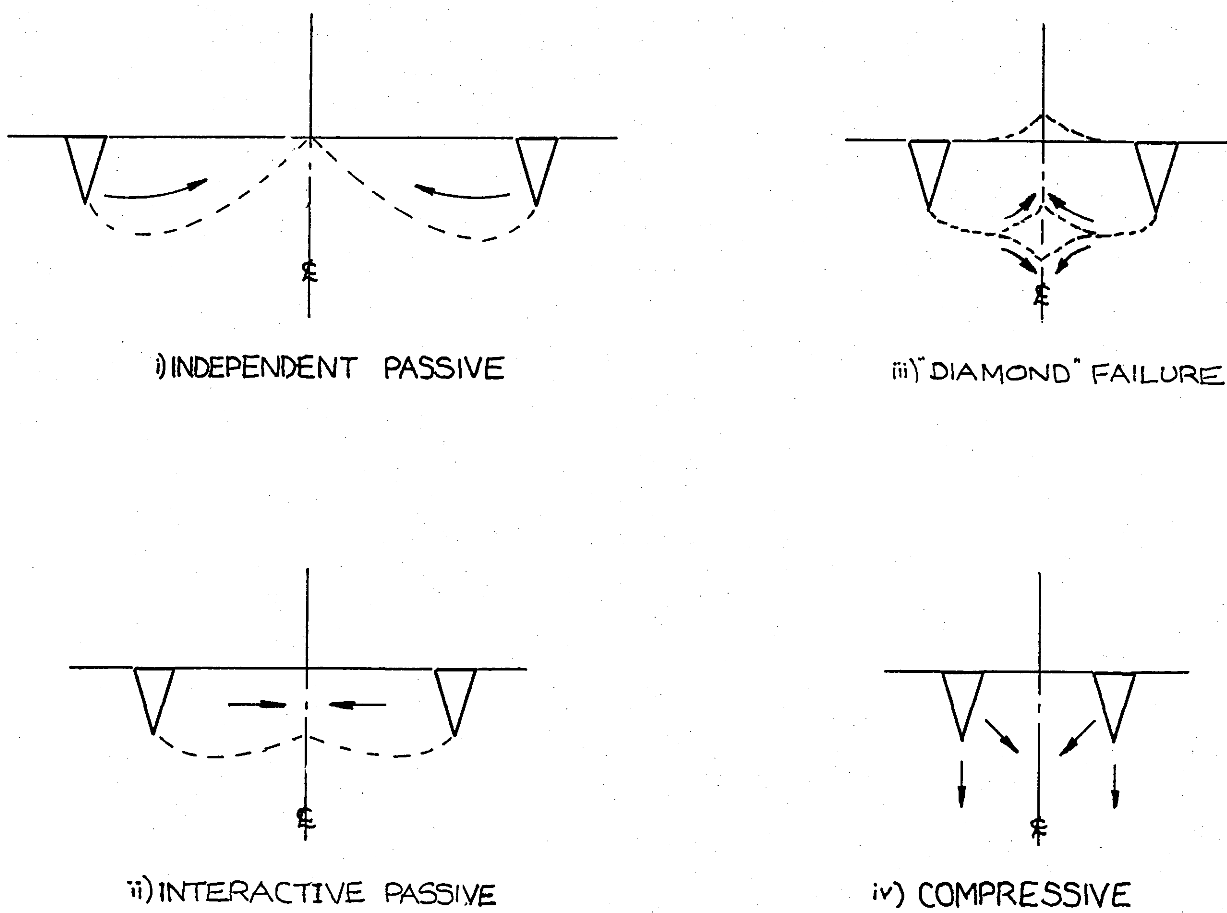


Fig 2.2.3 Soil Failure pattern under a pair of press sections

The type of failure described by ii) and iii) was thought capable of generating constraining forces and would allow clod breaking or better consolidation. To test this, Ansell continued the two-dimensional study with further tests on a combination press. Combinations of two medium and one wide were used, at various spacings, and various amounts of lag (equivalent to different diameters).

The observations made were that the combination penetration force was greater than the sum of the forces for the individual parts. There was a considerable reduction in surface dilation compared to three medium feet. This was found to relate to the four failure patterns, thus :

i) If failure system 2 is occuring (at the moment the wide foot reaches the surface) there is little penetration, little consolidation at depth, but large sideways confinement of the surface layers

ii) If failure system 3 or 4 is occuring then there is more penetration, more consolidation at depth, but less sideways confinement

iii) If failure system 1 is occuring, then there is the least penetration and consolidation at depth, but greater consolidation of the surface layers.

A brief test of the clod breaking abilities of a composite press was conducted but was inconclusive - the clods which were under a section broke, those which were not, did not break. Any increases in breakage could have been due to the increase in area covered by presses.

Two areas appeared not to have been fully explored. There has been much work conducted by Sanchez and Dauda looking at the effect of angle of the presswheel but in all cases a change in angle was associated with a change in width, and it is difficult to separate the effects of the two.

A further investigation into the clod breaking abilities of a composite press is required, comparing a wider range of combinations and using a more effective test technique.

SECTION 3 : 2-DIMENSIONAL CLOD BREAKING

3.1 Summary

To investigate the effectiveness of various composite press combinations in terms of clod breaking a series of experiments were conducted using a two-dimensional model. An increased number of clods was used than in the brief investigation made by Ansell (1986)

3.2 Experiments

This series of experiments was conducted using a glass fronted soil tank measuring 1200mm x 300mm x 200mm, enabling the effects of furrow press sections to be studied in the two dimensions of interest. ie. sideways and vertical.

Hemispherical clods were produced by packing damp soil into a mould. The soil used was from the Silsoe College soil bin i.e. a sandy loam (sand 73%, silt 10%, clay 17%). The clods were made with a moisture content of approximately 17% (dry basis), then dried at 75° C for 8 hours, producing a final moisture content of approximately 7%. When dry, the clods required a force of between 30 and 50N to fail in a brittle manner under axial loading. The flat side of the clods was painted in order that cracks could be recorded on a video recording. Unfortunately the paint was absorbed into the soil and produced a strengthened surface layer about 2mm thick. The clods broke behind the surface, but not on the surface and could not be seen or recorded as broken. The white paint was replaced by chalk-dust. This allowed the clods to break, but it was found that hemispherical clods could not be restricted to movement in two dimensions, and moved relative to each other rather than break.

A single slab of the soil was then made, 25mm thick and measuring approximately 400mm x 150mm. The same process as before being used. It was found that a slab this size could rarely be baked and never be handled without cracking.

A technique was developed where a tray was filled with damp soil to a depth of 25mm and then divided up into 38mm squares. The entire block was then dried as before, and then the individual "bricks" taken out and used. They were again dusted with chalk. These bricks were used to build a wall three bricks high by ten long, with a half brick stagger. The wall was built adjacent to the glass front of the soil tank and sandy loam soil was compacted to a density of approximately 1300kg/m^3 behind and to the sides of the bricks.

The press sections used are described in Fig 2.2.1 and were attached to a frame using clamping plates (Fig 3.2.1). This assembly was then attached to a hydraulic ram which was used to lower the feet into the soil.

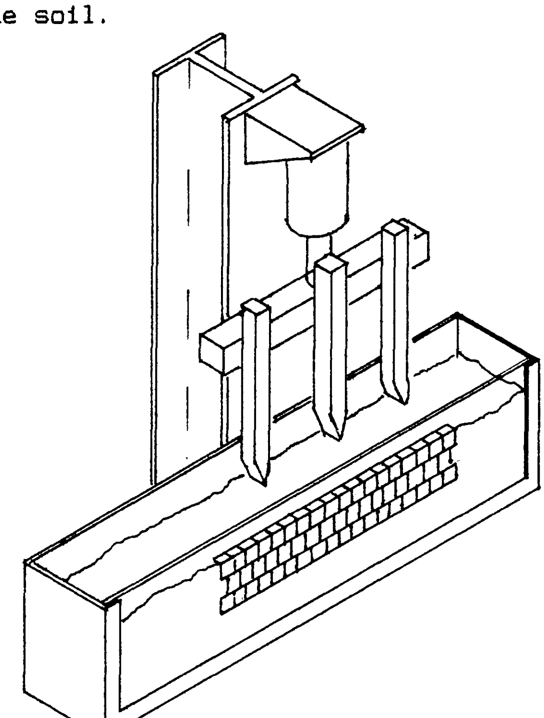


Fig 3.2.1. Experimental Arrangements used for 2-Dimensional modelling

In this range of experiments it was decided to not only use combinations with a central wide foot, but combinations using angled press sections as well.

Spacing always refers to the spacing between the larger diameter sections, with the smaller section being equidistant between the outer two. Lag refers to the difference in radius of press wheels.

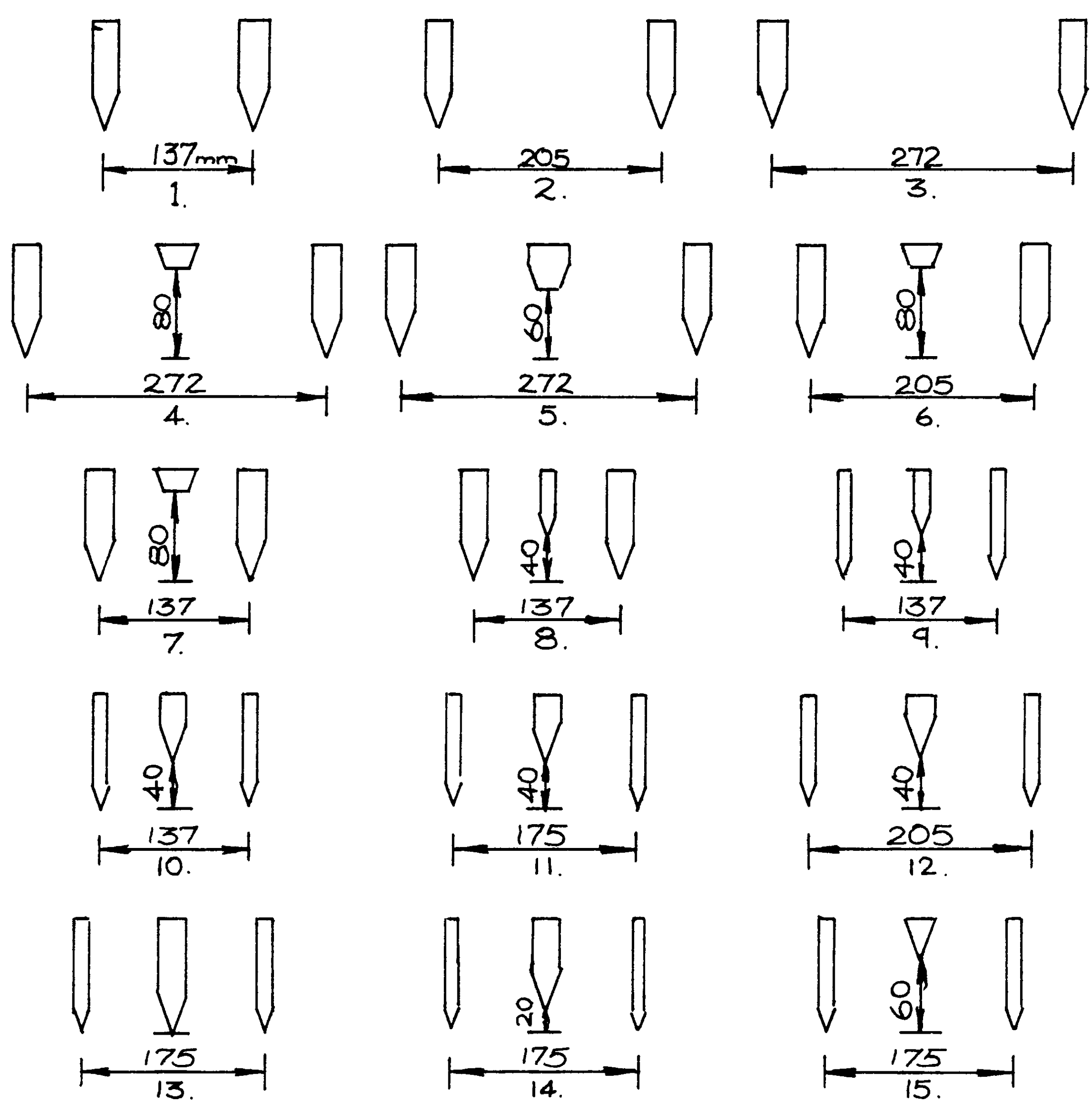


Table 3.2.1 Treatments used during clod breaking tests

In each case the experiment was recorded using a video camera. A grid of squares had been drawn on the glass and using this, the position of the clods were drawn onto paper. A simple colour key was used to differentiate between whole, cracked, and smashed clods. The number of clods in each state was also expressed as a percentage of the number of clods between the outer press sections. In order to establish deformation at depth a layer of chalk dust was placed under the bottom layer of clods and its movement under the outer feet measured.

3.3 Results and Observations

The results are given in Appendix I and in Table 3.3.1.

Treatment	Deformation at depth (mm)	% clods between outer feet : Smashed	Cracked	Whole
1	3	56	22	22
2	7	27	20	53
3	13	24	14	62
4	10	38	19	43
5	0	28	14	58
6	4	40	33	27
7	0	36	18	46
8	5	54	19	27
9	6	45	36	19
10	7	91	9	0
11	16	62	15	23
12	13	53	13	34
13	0	38	24	38
14	0	54	15	31
15	1	38	24	38

Table 3.3.1 Percentage of clods broken

The tests can be regarded as falling into five mini-series.

(i) Increasing separation (1,2,3), using two medium feet (50mm wide, 34°) at different spacings, representing a conventional press.

(ii) Combinations with flat foot (4,5,6,7), using a combination of two medium feet (50mm wide, 34°) and a flat foot (75mm wide)

(iii) Combinations with different angled sections (8,9,10), using three narrow feet (25mm wide, 32°), two narrow feet and one medium foot (50mm wide, 34°), and two medium feet and one narrow foot.

(iv) Different separations all using combinations of two narrow feet and one medium foot (8,11,12).

(v) Different lags all using combinations of two narrow feet and one medium foot (11,13,14,15).

i) Increasing Separation

At all spacings, sideways displacement occured, and at the widest spacing, lifting occured in the top two layers. The widest spacing gave the greatest deformation at depth (13mm). At the medium spacing only the top layer was lifted, and deformation at depth was reduced to 7mm.

The narrowest spacing resulted in no lifting between the feet, and very little deformation at depth (3mm). The narrowest spacing gave the best clod breaking, leaving 22% unbroken compared to 53% at the medium spacing and 62% at the widest spacing.

ii) Flat Foot Combinations

Comparing 80mm and 60mm lags at the widest spacing (272mm) showed that a lag of 80mm gave better results, with 43% unbroken compared to 58% and allowed more deformation at depth, (10mm against no deformation). The medium spacing gave the most complete breakage (27% unbroken) with a compacted surface just below the original level. The narrowest setting broke only the top layer and those bricks under the medium feet, leaving 46% of the whole clods, and producing no deformation at depth.

iii) Different Combinations using different angled sections

In terms of clods broken the best results were achieved using two narrow and one medium feet, leaving no unbroken clods. All three arrangements tended to lift out the broken or whole clods when withdrawn suggesting that the spacing was too narrow to be of practical use. The narrow section had an included angle of 32°, the medium ones 34°. Deformation at depth was similar in all cases.

iv) Different Spacings using two narrow feet and one medium foot

All these arrangements gave excellent clod breaking results, 175mm appeared to be the narrowest spacing before lift out occured. The narrowest spacing left 0% unbroken but tended to block between the sections. The 175mm spacing left 23% unbroken and the widest spacing 34%. Deformation at depth was similar for the two wider cases at 13mm and 16mm, compared to 7mm for the narrower spacing. In all cases the surface was left around 20mm below the original.

v) Different Lags using two narrow feet and one medium foot

With all three feet level, no disturbance at all was recorded below the second level resulting in 38% of clods being left unbroken. A 20mm lag improved this but left whole clods on the surface, 31% in total. A 40mm lag left only 23% of clods unbroken, and created the greatest deformation at depth of 13mm. A lag of 60mm resulted in an increase in unbroken clods to 38% and a reduction in deformation at depth to 1mm.

3.4 Discussion

i) The failure system in the first series of tests fits the model described by Ansell (1986). At the widest spacing, the top two layers lifted, this represents failure system 3. With the feet fairly wide apart, soil flow is around a diamond zone lower down. As the spacing decreases, the diamond zone rises and thus only the top layer moved. With the narrowest setting, compressive failure (4) occured and hence no lifting at all. The narrowest spacing broke clods well in a compressive manner but deformation at depth was prevented, with the sections acting as a single roller.

ii) The wide foot presents such a wide area that its action is like that of a flat roller, and will have no effect beyond the first 40mm. Therefore, for a soil profile of 120-150mm deep, the lag would have to be at least 80mm. At the narrowest setting, there was very little space for soil to move between the feet and therefore penetration was limited. This combination if used in the field would produce alternative areas of deformation at depth and compacted surface layers but not a combination of the two.

iii) The constraining force produced by either narrow or medium tines would be similar, a narrow tine being preferable since it will reduce the likelihood of purely compressive failure occuring. A medium tine performed best as the central foot, because it produced a greater wedging effect due to being twice as wide as a narrow foot; for the spacing used a reduction in the area between the outer sections of 44% compared to 22% for three narrow feet.

iv) The spacings determined here were probably linked to the clod size chosen, and must be considered again in fieldwork. The results showed good clod breaking, with a definite improvement over conventional presses, 0% unbroken against 22% at 137mm spacing and 34% unbroken against 53% at 205mm spacing.

v) With all the feet level, totally compressive failure occurred and limited penetration. A similar situation occurred with a 20mm lag but with a reduced effect. A 60mm lag produced very little effect because the outer feet were almost at maximum penetration and thus any confinement stresses generated have been dissipated in the form of unwanted soil movement ie. forwards and backwards. With conventional press wheels, the rim is only about 75mm deep and so will not be capable of generating much confinement by the time the smaller diameter wheel reaches the surface. A lag of 40mm gave both the best clod breakage (23% unbroken) and the greatest deformation at depth at 13mm.

3.4.1 General

In some cases, combination presses gave considerably improved clod breaking or consolidation. The best arrangement from these tests for clod breaking appeared to be two narrow and one medium feet, with a spacing of 175mm, and a lag of 40mm which left 23% unbroken. Better results were obtained at narrower spacings but resulted in soil being removed from the surface in between the press sections. For consolidation of surface layers a combination of two medium, and one flat foot, with a spacing of around 205mm and a lag of 80mm gave the best results, producing the most evenly compacted surface, at a level of 25mm below the original. It must be born in mind that these dimensions may be related to the size of clod chosen and a range must be further tested.

SECTION 4 FURROW PRESS SHAPES

4.1 Objectives

Despite work performed by Dauda (1986) considering different angles of presses, very little work had been conducted looking at a very wide range of included angles. The angle changes that Dauda used also involved a change in width and depth. In this series of experiments, the aim was to make the "overall" dimensions the same in all cases. It was hoped that an optimum included angle could be found for soil disturbance.

4.2 Methodology

A glass-fronted soil bin was used, together with the apparatus described in Section 3.2 to test the effects of included angle on soil disturbance. This time, force and penetration were also measured. The former by means of an Extended Octagonal Ring Transducer as described by Godwin (1975) and the latter using a Linear Variable Displacement Transducer.

The outputs from these transducers were fed into a Eicon A/D converter and data recorded on disc by an Apple Computer.

The soil used was the same sandy loam as described in Section 3.2, with a moisture content of approximately 6% (dry basis) and a bulk density of approximately 1200kg/m^3. A compact layer was prepared in the bottom 50mm of the bin, on top of which was placed a line of chalk dots, 20mm apart. This was achieved using a tool constructed using a length of 38mm x 38mm RHS with holes drilled along one edge at 20mm intervals (Fig 4.2.1). A 20mm layer of loose soil was poured in over a line of dots and levelled off. This process was repeated to produce five layers of dots with a layer of soil above.

The feet were again lowered hydraulically into the soil, and the same video recording equipment was used. Care must be taken when using video cameras to record things such as movement which are to be compared at a later date, to avoid altering the zoom length, which alters the size of the image on the screen.

The feet to be tested ranged from included angles of 30° to 120° in 30° increments and 180° . Three other profiles were also tested, described as curved narrow, curved wide and combination (Fig 4.4.2)

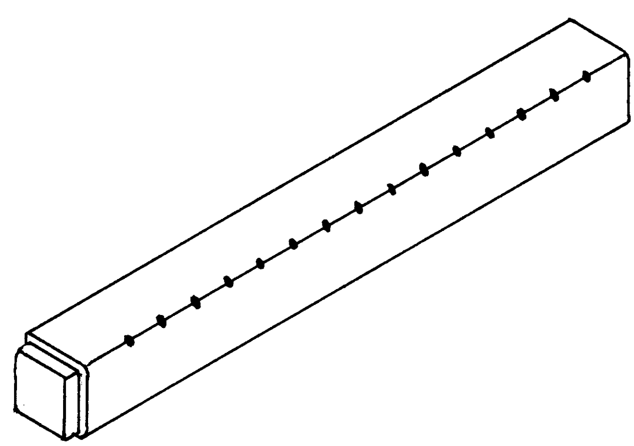


Fig 4.2.1 Tool for placing chalk dots

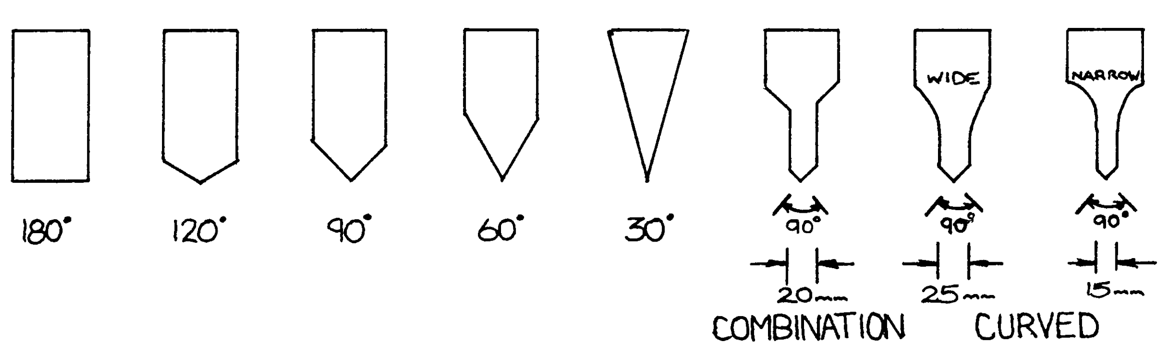


Fig 4.2.2 Different Profiles used in 2-Dimensional tests

All the feet were made from 65 x 65mm RHS x 100mm long thus keeping the overall dimensions the same, ie. width at the shoulders and depth from the tip to shoulder. In this way it was hoped that the penetration force could be compared.

Two of each type were made, and they were each tried at three different spacings, 140mm, 190mm and 240mm. Three replications of each arrangement were performed. In the course of the testing it was found necessary to modify the frame to prevent the feet moving away from the glass.

4.3 Results and Observations

4.3.1 Soil Movement

From the pictures on the video, the positions of the chalk dots following the penetration of the feet were recorded. The penetration was to a depth of 140mm.

The representations of the soil movement are given in Appendix II. A typical example is shown in Fig 4.3.1. Where a dot is not shown, it has disappeared from the screen, where two dots are shown from one point, the chalk dust has separated. Soil movement was classified into five directions: vertically up, vertically down, horizontally and 45° up and 45° down. The results are given in Table 4.3.1.

The results are :

i) 30° - High sideways movement at medium and wide spacing with very little lifting in all cases, no apparent diamond zone. Downward movement decreases with increasing separation.

ii) 60° - General downwards movement, with lifting between feet increasing with spacing. Not much difference between spacings except for the diamond zone movement, measuring around 20mm square which moves from 40mm to 80mm below the surface between the narrow and wide spacing.

iii) 90° - Almost purely downward movement at the narrowest spacing, with an increase in lifting at the medium spacing, around a diamond zone at around 80mm depth. Almost no downward movement at the widest spacing, it being replaced with upward and horizontal movement. The widest spacing acts nearly as independent feet.

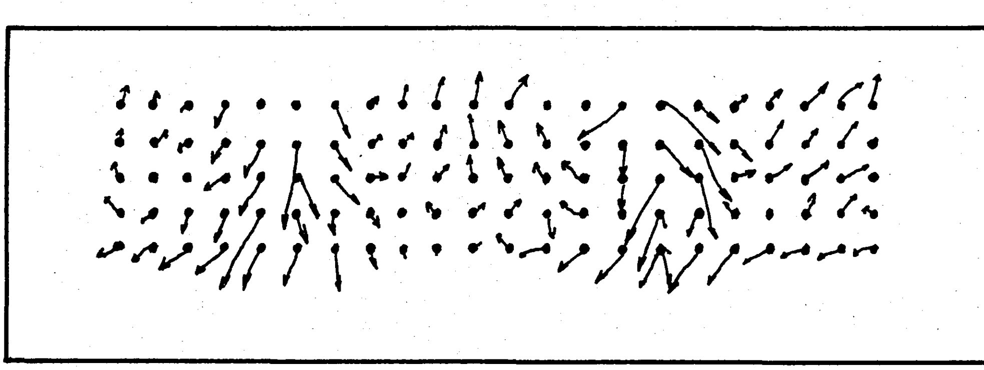
iv) 120° - All spacings gave around 50% upward movement and produced considerable lifting between the feet. The widest spacing was the only one to produce noticeable horizontal movement.

v) 180° - Predominately downward movement at the narrowest spacing but the other spacings were fairly evenly split between up and down movement. Almost no areas with no movement except at the widest spacing.

vi) Curved-Narrow - Predominately downwards movement at the narrowest spacing, with more horizontal movement with the other spacings. Very little upward movement in all cases. More vertical movement in the lower strata than the top.

vii) Curved-Wide - Similar to the narrow but more downward movement. Very little lifting of the surface layers.

viii) Combination - The narrow and medium spacings produced mainly downward movement, but the widest spacing produced much more uplift. The amount of disturbance was fairly limited at the two wider spacings.



120°-MEDIUM

Fig 4.3.1 Typical Soil Movement Patterns

4.3.2 Force Penetration

The graphs of force-penetration are given in Appendix III. Note that the soil surface was 50mm below the point where penetration depth was measured from. The average curves (medium spacing) for different angles are given in Fig 4.3.2. Force against included angle is shown in Fig 4.3.3. The force was measured at a depth of 140mm.

Angle	Spacing	No Movement	Up	Down	45° Up	45° Down	Horiz.
30°	140mm	3%	3%	22%	3%	53%	16%
	190mm	2%	0%	15%	4%	32%	47%
	240mm	2%	5%	11%	5%	6%	71%
60°	140mm	10%	10%	40%	3%	37%	0%
	190mm	4%	17%	45%	6%	22%	6%
	240mm	0%	23%	32%	11%	21%	13%
90°	140mm	6%	3%	53%	0%	25%	13%
	190mm	2%	14%	41%	6%	25%	12%
	240mm	4%	18%	4%	27%	16%	31%
120°	140mm	7%	37%	27%	13%	13%	3%
	190mm	7%	25%	22%	24%	15%	7%
	240mm	0%	42%	11%	13%	9%	25%
180°	140mm	0%	0%	32%	5%	42%	21%
	190mm	2%	38%	23%	11%	11%	15%
	240mm	11%	38%	13%	9%	22%	7%

Angle	Spacing	No Movement	Up	Down	45° Up	45° Down	Horiz
CN	140mm	0%	3%	32%	9%	50%	6%
	190mm	2%	0%	28%	2%	28%	40%
	240mm	5%	0%	37%	0%	34%	24%
CW	140mm	0%	0%	43%	9%	31%	17%
	190mm	0%	0%	68%	4%	28%	0%
	240mm	2%	0%	29%	0%	42%	27%
Comb	140mm	3%	8%	30%	3%	43%	13%
	190mm	24%	0%	42%	0%	32%	2%
	240mm	8%	20%	8%	27%	3%	34%

Table 4.3.1 Percentage of particles moving in each direction.

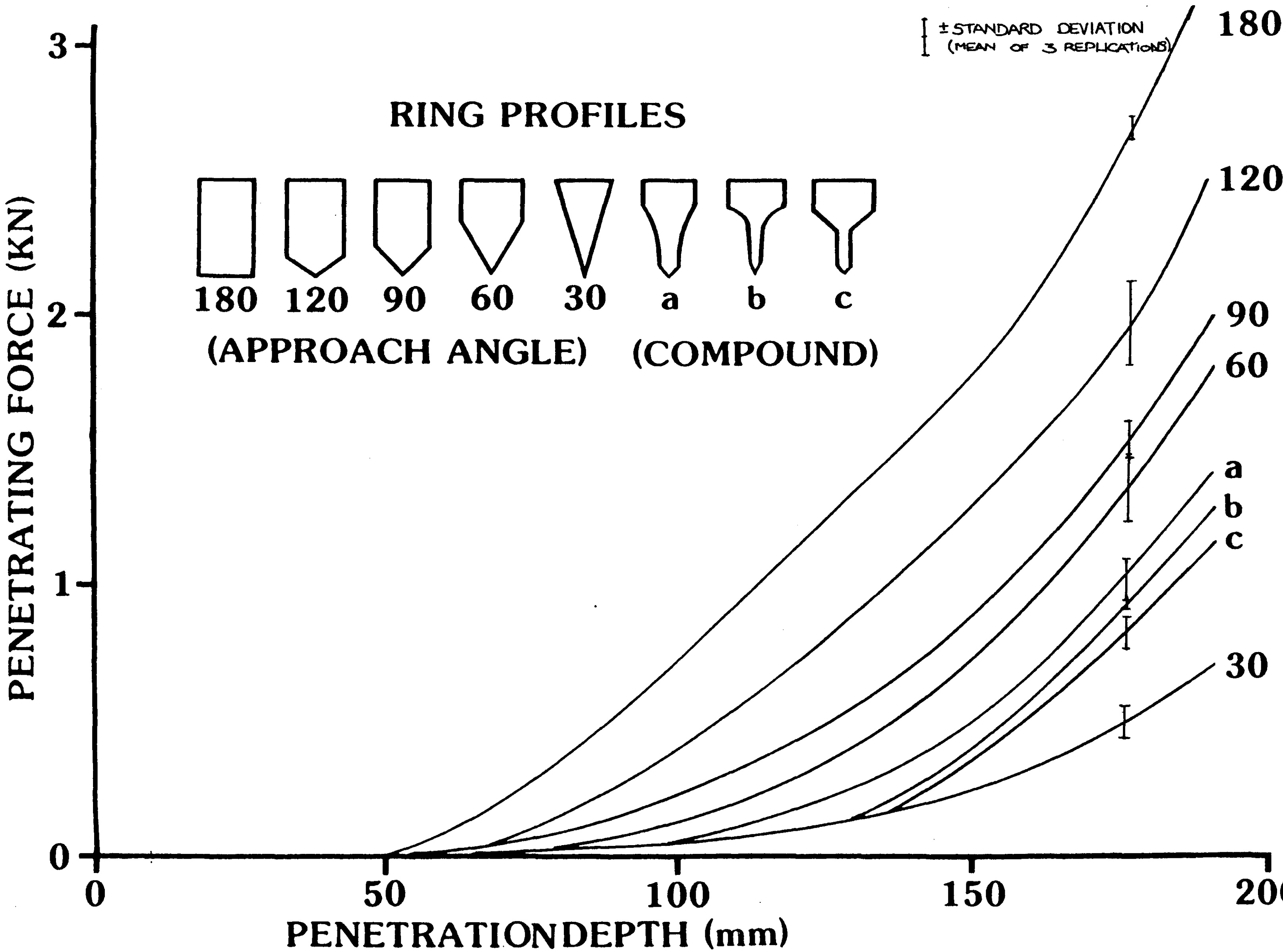


Fig 4.3.2 Penetrating force against depth curves for different included angles

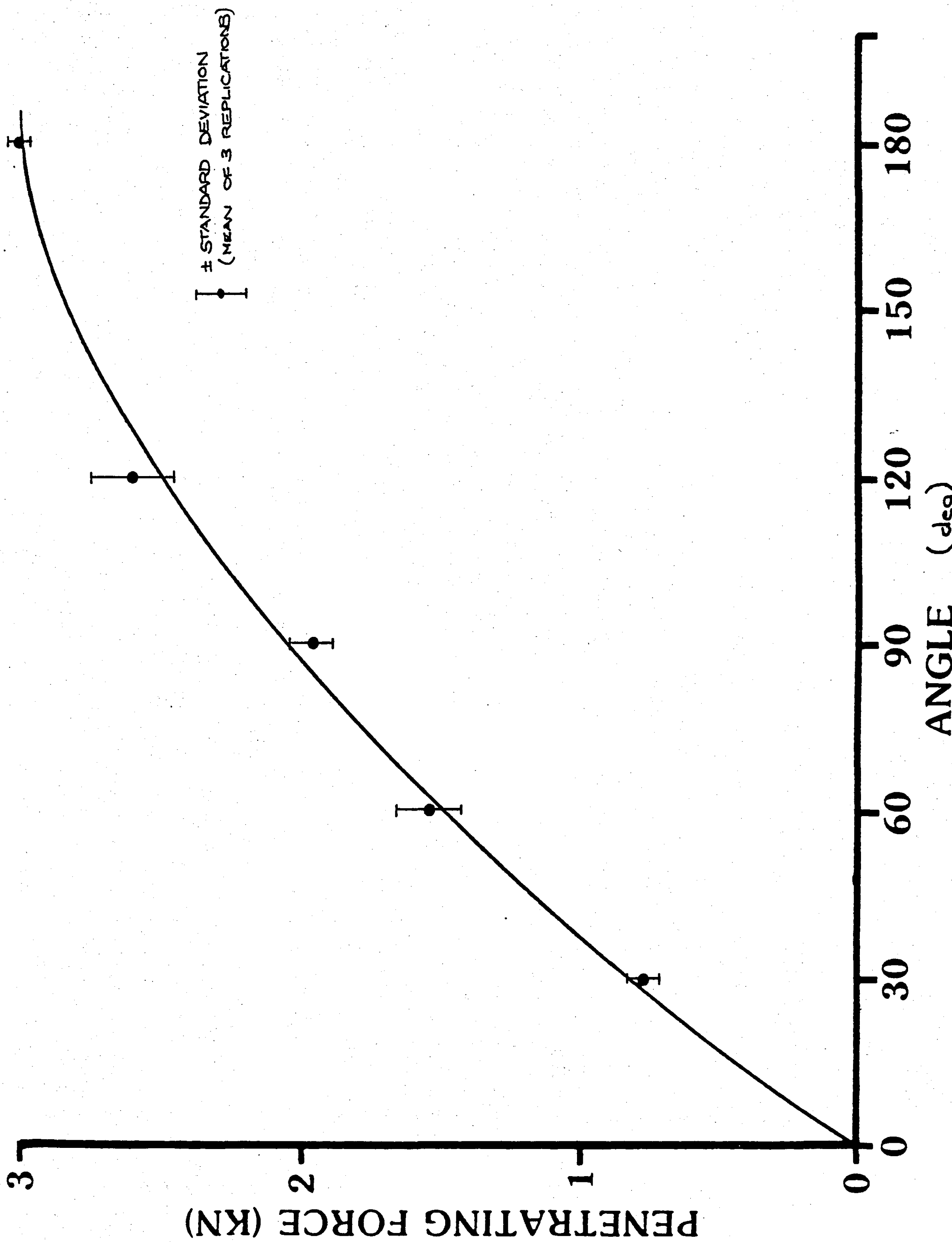


Fig 4.3.3 Force required to penetrate to 140mm for varying included angles

4.4 Discussion

4.4.1 Soil Displacement

In nearly all the cases, soil movement was found to link with the conclusions of Dauda (1985), in that soil was displaced sideways and vertically, both up and down.

Depending upon the included angle of the press section used, the soil failure type varied from 60° narrow which produced a compressive failure, to the 30° wide showing interactive failure and finally the 90° wide producing almost independent failure.

It can be seen that the failure systems proposed by Ansell are not only affected by spacing but included angle as well.

For the five included angles it can be seen that disturbance patterns changed with angle. From a largely horizontal pattern at 30° to nearly vertical movement with 180° feet. Penetration and deformation at depth remained virtually unchanged with all the arrangements, but it must be remembered that these feet were being forced in by a force which increased to meet the resistance. In a practical press situation the penetrating force is limited by the weight of the press and cannot increase other than by adding ballast. Surface dilation also increased greatly with angle.

The three different profiles performed similarly to each other. They all left a reasonably unchanged surface layer and gave a fair compaction at depth. Their performance was similar to an angled foot of between 30° and 60°. Soil appeared not to flow around the shapes but to form slip planes along a line from the shoulders to the point.

In general, increasing spacing changed the soil movement from downward compressive to an interactive movement, creating uplift between the feet.

4.4.2 Force Required

The graph (Fig 4.3.3.) shows the relationship between force and penetration for different included angles. There is a smooth rise of force against angle up to an included angle of 120°, after which the rate of increase of force decreases rapidly. The increase in force is probably due to the increase in soil displacement which is a function of angle. The three compound angle feet lie midway between 30° and 60°, again suggesting that they act as a straight sided foot. With the narrow-curved and the combination feet, the force-penetration curve changes slope after about 70mm penetration. The change is not enough to warrant further study of these profiles, as a possible way to prevent over-penetration.

4.4.3 General

In order to achieve penetration given a limited penetrating force smaller included angles are required. Smaller angles also produce the greatest sideways movement required to develop confinement stresses for effective operation of the composite press principle. Larger angles produce unwanted surface dilation.

Compound curve profiles have little effect on either penetration or soil disturbance when compared to feet of the same overall dimensions ie. width at shoulder and point to shoulder distance.

SECTION 5 : COMBINATION PRESSES IN THE SOIL BIN

5.1 Objectives

To discover whether composite presses would offer improved performance, a number of full size presses were made and tested in the Silsoe College Soil Bin.

5.2 Methodology

Six wooden press rings were made, two each of three diameters (650mm, 600mm and 550mm). They were constructed by screwing two discs of 25mm Waterproof Plyboard together, giving a 50mm wide press wheel. These discs were then turned on a lathe to give an included angle of 34° to produce a medium profile wheel. A 50mm hole was drilled through the centre, and a steel plate, bolted on either side to act as a plain bearing (Fig 5.2.1).

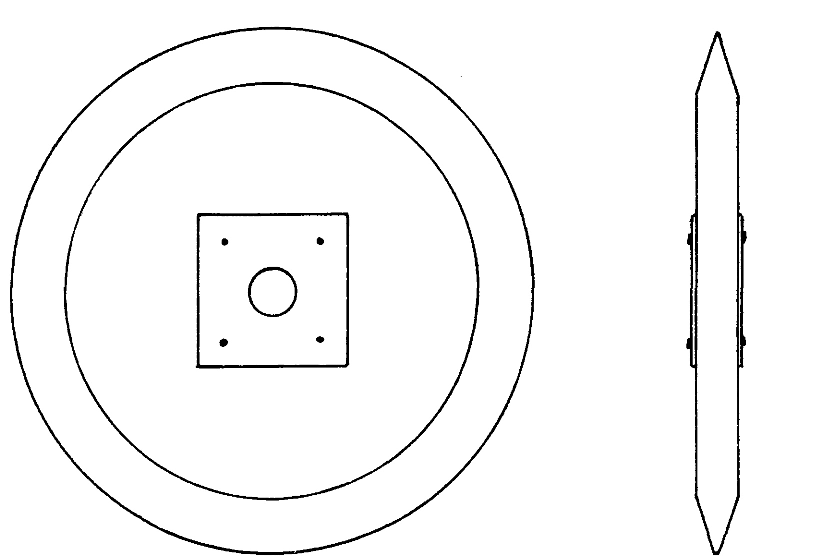


Fig 5.2.1 Wooden press wheel

The edges were impregnated with thickened glass fibre resin, to help protect the sharp edge. The entire wheels were then painted.

An existing furrow press frame was used, but the central brace removed to allow any spacing combination to be used. A linkage consisting of two pin joints was used to pull the press, but not transfer any appreciable vertical force. The linkage was attached to an Extended Octagonal Ring Transducer (Godwin 1975) mounted on the soil processor which was only used to measure draught.

The soil used was a sandy loam (sand 73%, silt 10%, clay 17%) and was prepared in the following way :

i) Soil was removed from the test area to a depth of 200mm

ii) Five layers each of 50mm were built up

iii) No rolling or keying of the layers was carried out

This procedure gave an average bulk density of 1330kg/m^3, with a standard deviation of 30kg/m^3. The moisture content was kept at around 8% dry basis.

Twelve runs were scheduled, each at three weight levels but a further run (13) became necessary to compare similar weight/ring ratios (table 5.2.1)

Soil profiles were measured for each weight level and are given in Appendix IV.

In addition to the profile, penetration resistance was also measured using a recording cone penetrometer. The same instrument was used to perform a plate sinkage test using a 30mm diameter plate. Each run was also recorded on a video recorder.

RUN 1	3xNARROW @	700mm dia	2xMEDIUM @	650mm dia	205mm sp
RUN 2	" "	" "	" "	600mm	"
RUN 3	" "	" "	" "	550mm	"
RUN 4	" "	" "	" "	550mm	290mm
RUN 5	" "	" "	" "	600mm	"
RUN 6	" "	" "	" "	650mm	"
RUN 7	" "	" "	" "	650mm	180mm
RUN 8	" "	" "	" "	600mm	"
RUN 9	" "	" "	" "	550mm	"
RUN 10		Conventional Press			180mm
RUN 11(13)	2 "	" "	1x100mm FLAT	600mm	220mm
RUN 12	" "	" "	1x150mm	" "	265mm

WEIGHT	1	206.5 kg	(68.8 kg/large ring)
"	2	312.5 kg	(104.1 kg/ " ")
"	3	418.5 kg	(139.5 kg/ " ")

Table 5.2.1 Experimental Treatments used in Soil Bin

The penetrometer profiles are given in Appendix V and a typical sample is shown in Fig 5.3.1. The figures on the right hand side of the main body of numbers are an arithmetical mean of the resistances under the press. Those under the main body are averages of each column. The top number being the average of the top 60mm, the second that of the middle 60mm, and the bottom 60mm is represented by the third number. The bottom number is the average for the column. The numbers in the bottom right hand corner are averages for each 60mm layer across the pressed width, and an average of these numbers at extreme bottom right. The penetrometer did not touch the soil surface until depth level six. The depth levels are in 20mm increments.

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5			0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0
6	30	120	180	150	60	0	0	180	0	0	120	50	0		60	210	90	0	13.3
7	180	270	390	240	120	0	30	0	60	0	270	0	30	0	150	300	150	180	43.3
8	210	300	390	330	270	60	180	120	270	0	540	150	210	30	300	360	180	330	173.
9	240	390	450	360	420	390	510	350	540	210	870	330	570	270	510	420	240	390	450
10	300	360	420	420	600	720	810	540	930	600	1080	660	870	660	630	480	300	390	763.
11	300	420	450	420	690	930	1080	810	1200	870	1380	930	1080	870	780	540	360	420	1017
12	330	450	450	510	750	1110	1230	1020	1380	1170	1560	1230	1320	1080	840	600	420	420	1233
13	330	480	480	540	840	1230	1380	1290	1560	1380	1740	1410	1470	1230	960	660	450	510	1410
14	420	600	510	570	930	1350	1500	1500	1680	1620	1860	1500	1680	1320	1050	840	480	540	1557
15	600	780	660	690	1230	1560	1500	[illegible]	1770	1830	1860	1800	1800	1530	1320	1020	630	660	1707
TOP						150	240	160	290	70	560	160	270	100					222.
MIDL						920	1040	790	1170	880	1340	940	1090	870					1004
BOTM						1380	1460	1500	1670	1610	1820	1570	1650	1360					1558
AV						817.	913.	817.	1043	853.	1240	890	1003	777.					928.

RUN8 · WT2

ALL UNITS ARE kN/m2

Fig 5.3.1 Typical Penetrometer Results Sheet

5.4 Discussion

5.4.1 Profiles

There was no significant difference between any of the profiles produced by the combination presses.

The amount of sinkage was measured in terms of area relative to the soil surface before pressing. The largest area of deformation was $0.285m^2$, created by Run 7, Weight level 3. This increased area was created by soil picking up from the surface and being transported on the press, leaving wide gulleys instead of the normal v-shaped marks.

The next highest was 0.174m^2 and the lowest 0.091m^2. In general, increased weight gave increased area of deformation but not in all cases. There was no direct correlation between area, spacing and weight.

The conventional press fell between the above figures, but had three deep grooves instead of five shallower marks. The combinations using a flat roller also produced deformations which fell within this range, and produced a more compact surface layer.

5.4.2 Draught

All the runs produced similar draught figures and there were no significant differences between them and are given in Appendix VI (for a given loading).

The average draught force for weight level one was 0.580kN with a standard deviation of 0.108kN. For weight level two a mean of 1.031kN and SD of 0.124kN. The third level produced a mean of 1.476kN and SD of 0.175kN. These show significant differences at the 0.1% level.

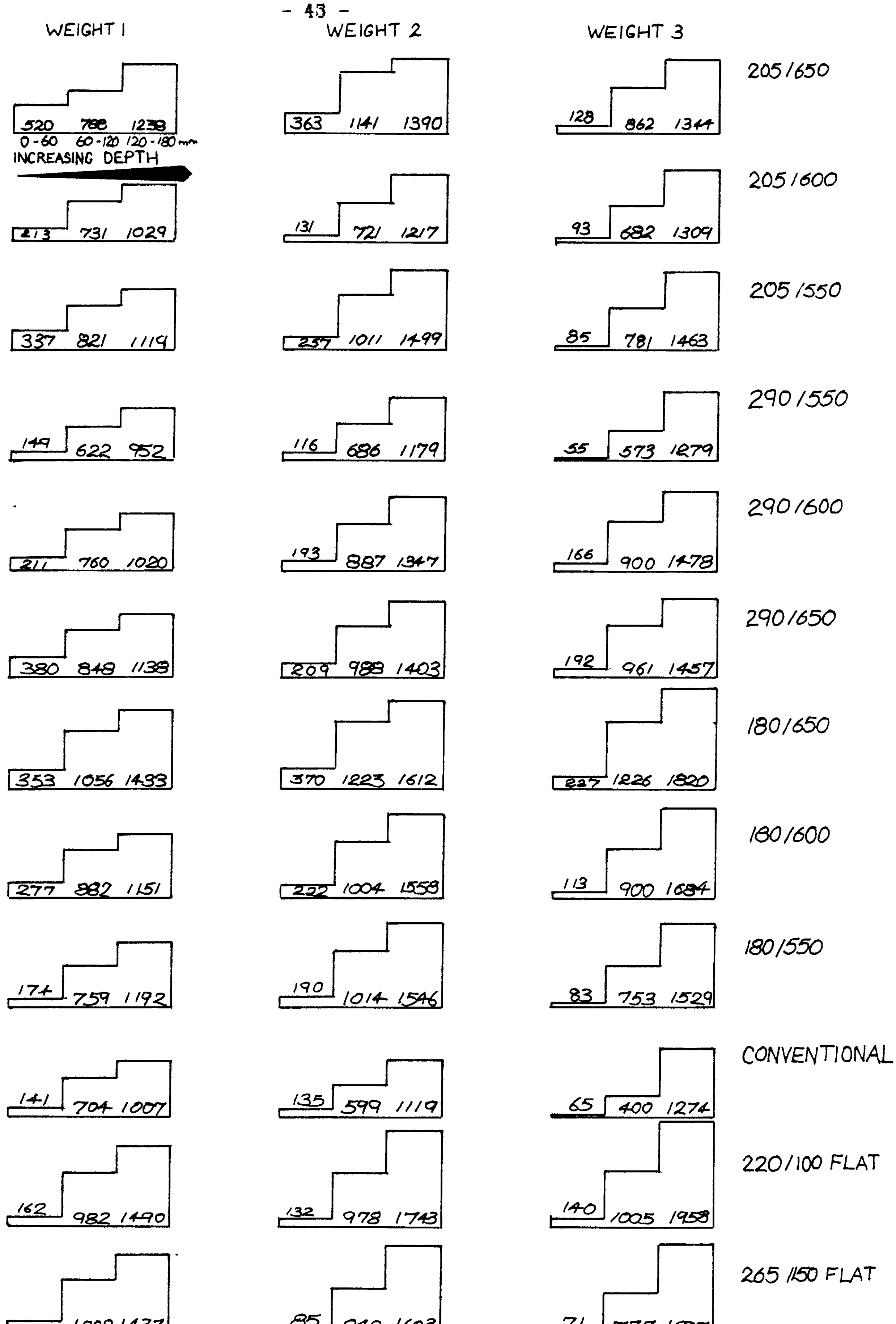


Fig 5.4.1 Penetration Resistance at different depths for different arrangements.

5.4.3 Soil Penetration Resistances

The results from the cone penetrometer show a wide variation with no real pattern. The penetrometer manufacturers recommend using a cone to give a reading of 40-50 (penetrometer units) at the bottom of the stroke. Using the cone in loose soil only gave average maxima of around 10 units. The results using a cone were not used for analysis.

The results obtained using a plate instead of a cone used a much wider range of figures, and therefore gave a more consistent reading. In terms of analysis, the three numbers giving an average resistance for the top, middle and bottom 60mm layers were of the greatest use. It was felt that the presses that gave the most even compaction distribution were those which showed the most improvement for use as light land consolidators (Fig 5.4.1), as it is easy at present to produce compaction at depth or in the surface layers, but not both.

The most important discovery was that increasing weight only increases compaction at depth and usually reduces compaction in the surface. In many cases, the total average resistance fell at the third weight level. This suggests an optimum weight for a given soil type and condition, above which, an actual decrease in compaction occurs.

Table 5.4.1 shows the top four arrangements for compaction in each layer.

Table 5.4.1 Optimum Arrangements for compaction at different depths

	OPTIMUM ARRANGEMENTS			
	Best	2nd	3rd	4th
Top 60mm	205/650/1	290/600/1	180/600/2	205/600/2
60-120mm	180/600/2	180/600/3	205/600/2	180/650/1
120-180mm	220/100flat/3	180/650/3	220/100f/2	265/150f/3
Average	180/650/3	180/600/2	220/100f/3	205/600/2

The numbers refer to Spacing/Dia of Combination or width of Flat Roller/Weight level.

It can be clearly seen that the combinations which gave the most even distribution in general terms use the 650mm diameter press wheel. No conclusions can be drawn about weight since they would only apply to these soil conditions.

There appeared to be no other obvious patterns linked to which combinations performed best. It was thought that enclosed areas under the presses might have some relationship but none could be found. Further consideration was given to a weight/area ratio value and its relationship to the success of the press. There was no correlation between the compaction and the weight/area ratio.

A further difficulty is in actually quantifying the degree of success of a press. When weight/area ratios were being compared, it was found that the ratios for the flat rollers were considerably different to those of the others. A lighter version was made and tested, and resulted in reduced compaction in the 120-180mm layer.

5.4.4 Summary

A composite press based on the angles predicted from previous work produced a much more uniform compaction in certain arrangements. The best combination in the soil bin was that combining narrow presses of 700mm diameter with medium presses of 650mm diameter at 180mm spacing.

There could be a decrease in average consolidation by adding extra weight, suggesting that a critical weight exists for a given press arrangement and soil condition, particularly on light land.

SECTION 6 : FIELD TESTING OF THE COMBINATION PRESS

6.1 Objective

In order to evaluate the performance of a composite press, a series of tests were conducted on different soil types.

6.2 Methodology

Seven different areas of land were used, and in most cases, the land had been ploughed for around 24 hours before pressing, where weather conditions permitted. All the results were collected within 24 hours of pressing. The weather conditions over the course of the testing were fair. Testing was conducted between the 1st and 22nd September. The soil types are given in Table 6.2.2.

Each test consisted of six different arrangements together with a conventional narrow ring press and a 1.2m wide Cambridge roll. The exact arrangements are given in Table 6.2.1.

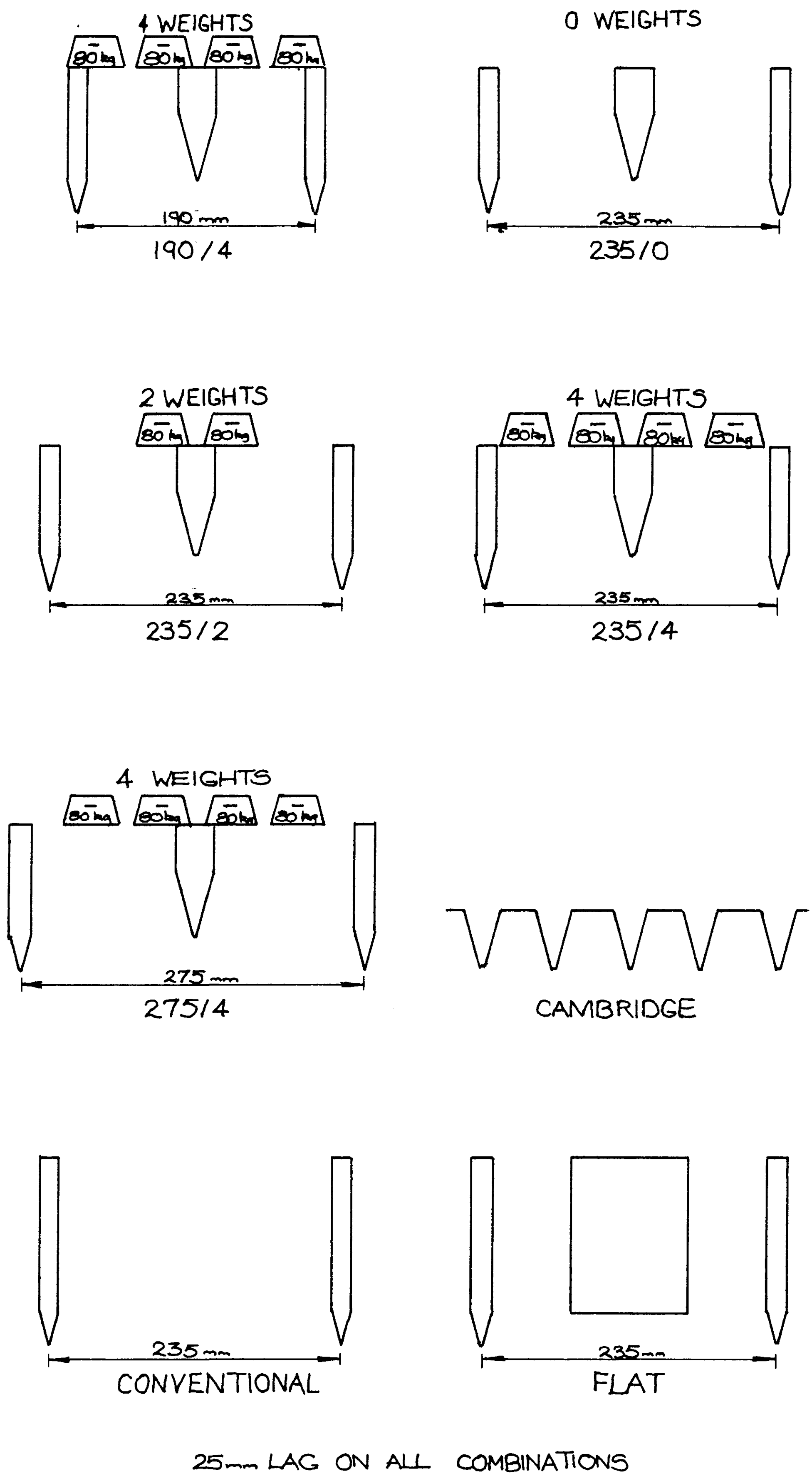


Table 6.2.1. Press arrangements used for field work

Two more press wheels of 650mm diameter were constructed as before (5.2), but were covered in steel sheet to prevent wear. This allowed the full width of the press to be used (5 narrow presses, 4 wooden presses). A headstock was constructed which enabled the press to be easily transported both on the road and in the field. In the field, the top link was replaced by a chain, thus allowing the press to follow undulations in the surface, and preventing any weight transfer from the tractor. When extra weight was added to the press it acted directly above the axle.

The soil conditions are given in Table 6.2.2.

Soil Code	Clay%	Silt%	Sand%	Classification	M.C.%
A	25.55	24.43	49.97	CLAY LOAM	14.98
B	23.50	31.29	45.21	CLAY LOAM	12.75
C	33.12	26.99	39.89	CLAY LOAM	13.34
D	15.22	18.63	66.15	SANDY LOAM	13.57
E	27.15	21.95	50.90	SANDY CLAY LOAM	20.61
G	34.34	26.49	39.17	CLAY LOAM	29.49
H	9.95	11.77	78.28	SANDY LOAM	12.48

Table 6.2.2 Soil Analysis of Field Sites

Each test site was arranged so that there were eight strips pressed, each one sharing one tractor wheeling with the last pass. All the passes were pressed in the same direction. When all the passes had been completed, a wooden peg was driven firmly into the ground in each wheeling. Using a straight edge and a spirit level, all the pegs were placed at the same level, around 150-300mm above the surface to give a reference level.

From this level, a profile meter was suspended and profiles recorded. The tractor was then driven over the pressed work (with the press raised), straddling the level posts, leaving a wheeling in each piece of work. The profile meter was again suspended over the work and the new profile recorded. These profiles could be superimposed to give a measure of the sinkage occurring. The sinkage was a measure of the soil strength, and was proportional to the degree of compaction.

Using a camera held above a 600mm x 600mm piece of 25mm weldmesh, photographs were taken of the soil surface. A second picture was taken of the same area without the grid, and this gave a better picture of the surface finish. The photgraphs of the eight treatments were compared with both each other, and the ploughed soil before pressing. The treatments were placed in order, based upon how well each press had reduced the average clod size on the surface. The best result was given eight marks, the worst case one point.

6.3 Results and Observations

The best improvements in terms of clod reduction are shown in Table 6.3.1, figures 6.3.1. and 6.3.2 and Appendix VII.

AVERAGE OF RANKINGS FOR EACH SOIL TYPE

	SOIL TYPE								
PRESS TYPE	A	B	C	D	E	G	H	TOTAL	95% LIMIT
									49.8
190/4	3.9	7.0	7.9	6.0	6.9	7.0	6.9	45.6	
									41.2
									45.7
235/4	4.7	7.4	5.5	5.9	5.3	7.2	6.0	42.0	
									38.4
									35.1
235/2	5.3	1.0	4.0	3.2	7.3	5.8	5.2	31.8	
									28.5
									34.2
CAMB	6.0	2.9	2.9	8.0	1.0	3.3	6.4	30.5	
									26.8
									29.3
275/4	2.3	4.9	6.8	1.0	4.0	4.9	2.9	28.8	
									24.3
									31.4
235/0	5.0	3.9	1.4	2.6	6.5	2.5	5.0	26.9	
									22.4
									29.1
FLAT	7.8	6.3	1.8	4.1	2.0	1.6	2.6	26.2	
									23.3
									25.7
CONV	1.0	3.4	5.7	5.2	3.0	3.7	1.0	23.0	
									20.3
									48.8
ALL 235	Best result for each soil type							44.7	
									40.6

8 Marks = Best Finish
1 Mark = Worst Finish
Best possible = 56

Table 6.3.1 Results of Photograph ranking for clod size reduction

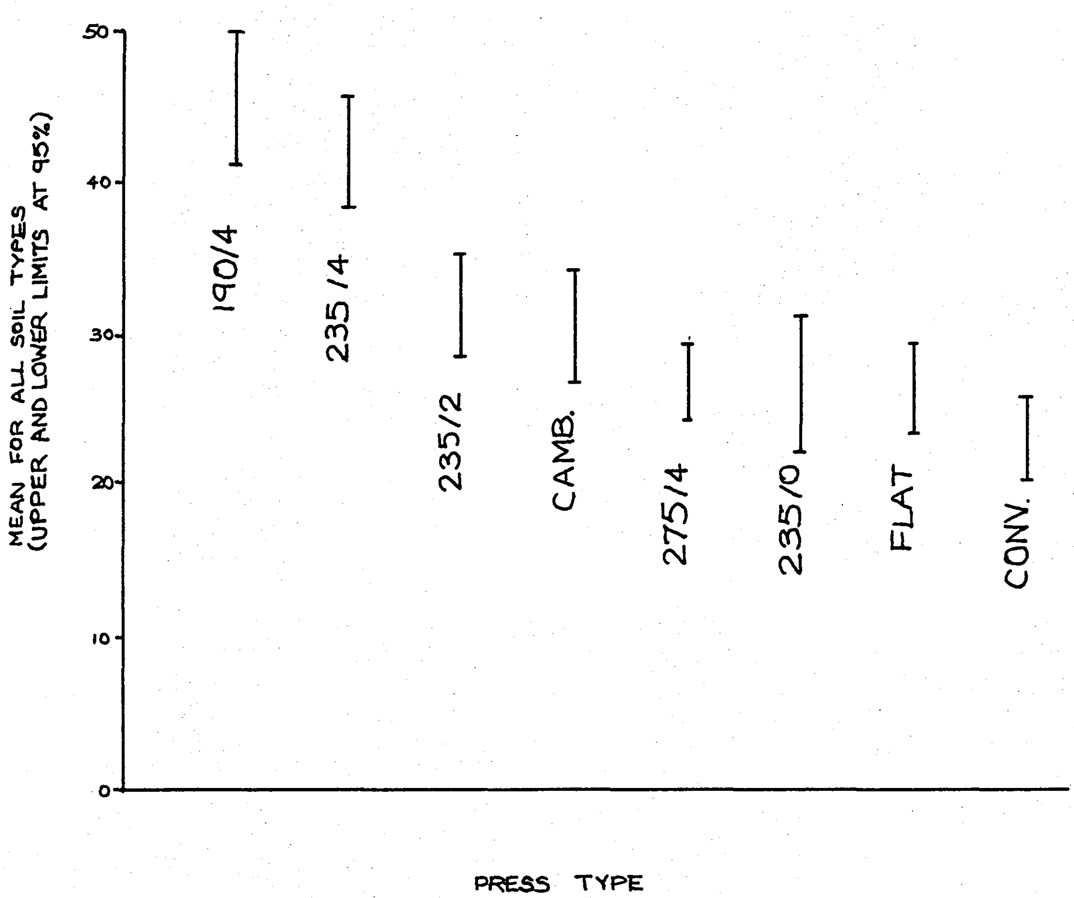
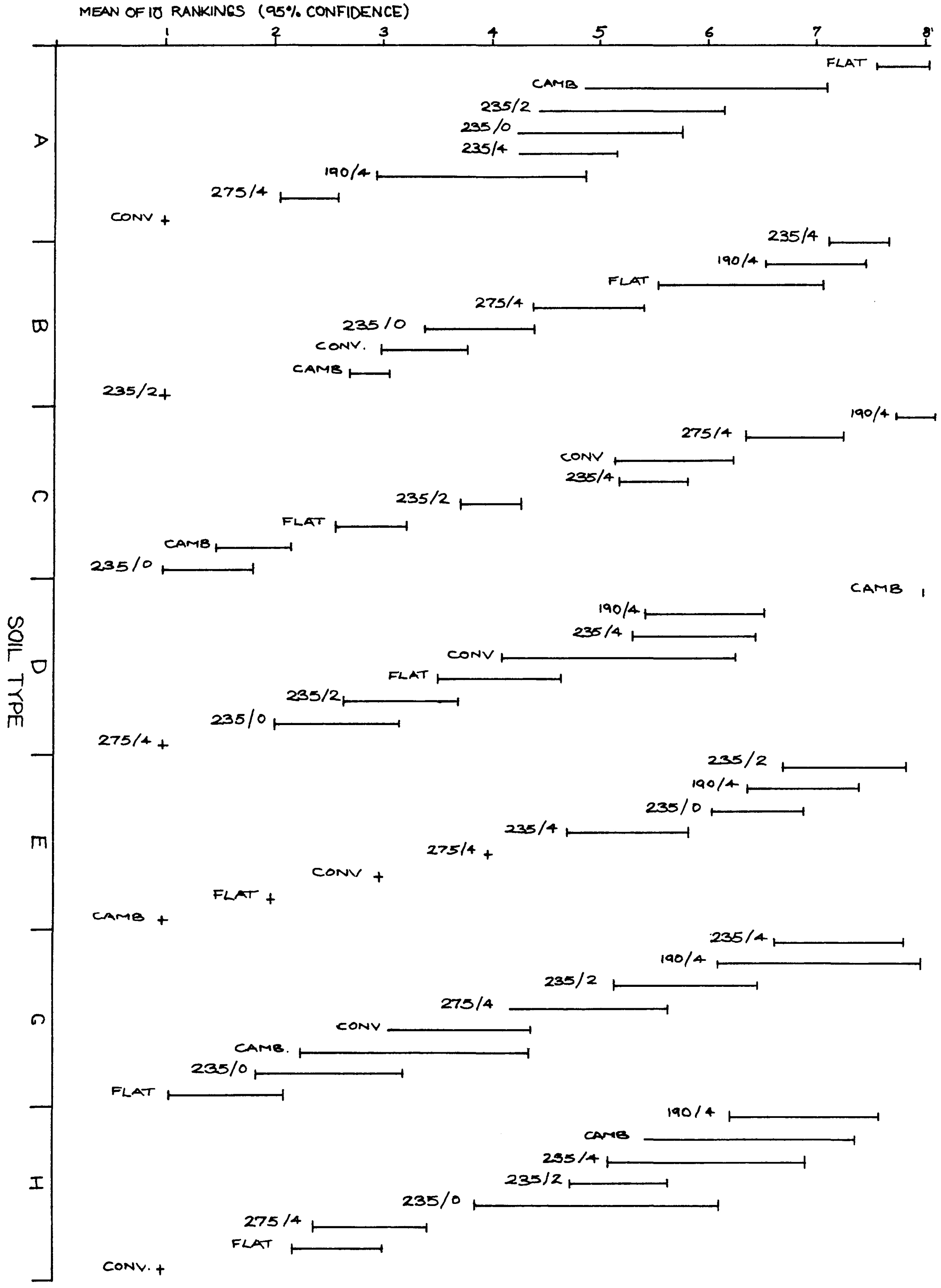


Fig 6.3.1 Positions of presses after addition of rankings for all soil types

Fig 6.3.2 Mean Rankings for each soil type



	SOIL TYPE						
PRESS TYPE:	A	B	C	D	E	G	H
	CLAY LOAM	CLAY LOAM	CLAY LOAM	SANDY LOAM	SANDY CLAY LOAM	CLAY LOAM	SANDY LOAM
190/4	5.2(68)	7.1(88)	4.3(79)	7.4(77)	1.3(15)	7.5(95)	8.4(80)
235/4	6.1(80)	12.2(152)	7.0(129)	13.0(136)	4.7(56)	8.7(110)	8.8(84)
275/4	8.9(116)	-3.2(40)	3.9(71)	3.9(41)	14.1(168)	8.3(105)	9.2(88)
235/0	9.0(118)	3.6(45)	0.7(13)	10.8(113)	12.2(147)	8.5(108)	13.7(131)
235/2	6.0(78)	2.9(45)	7.1(130)	9.6(101)	3.4(41)	5.3(67)	12.8(122)
235/4	6.1(80)	12.2(152)	7.0(129)	13.0(136)	4.7(56)	8.7(110)	8.8(83)
FLAT	10.1(132)	15.6(195)	4.8(88)	6.1(64)	9.0(107)	9.7(123)	6.9(65)
CONV	10.6(139)	0.9(11)	5.9(108)	18.8(197)	12.5(149)	11.1(141)	12.6(120)
CAMB	5.1(66)	24.9(311)	9.7(178)	6.5(68)	9.8(117)	3.7(47)	11.5(109)

Table 6.3.2 Sinkage of a tractor wheel on pressed soil.

The profile of the pressed work was measured and the arithmetical mean height relative to a datum established. From this mean height a theoretical line was drawn 200mm below. The soil between the bottom line and the profile was taken to be the effective section acted on by the press. The profiles recorded were 1000mm long, so an area between the bottom line and the profile could be calculated. Using the same box and a second profile (after a tractor wheeling) another area was calculated. The reduction in the area between passes expressed as a percentage of the original area is given in Table 6.3.2. The figures in brackets refer to the sinkage expressed as a percentage of the mean sinkage for that soil type.

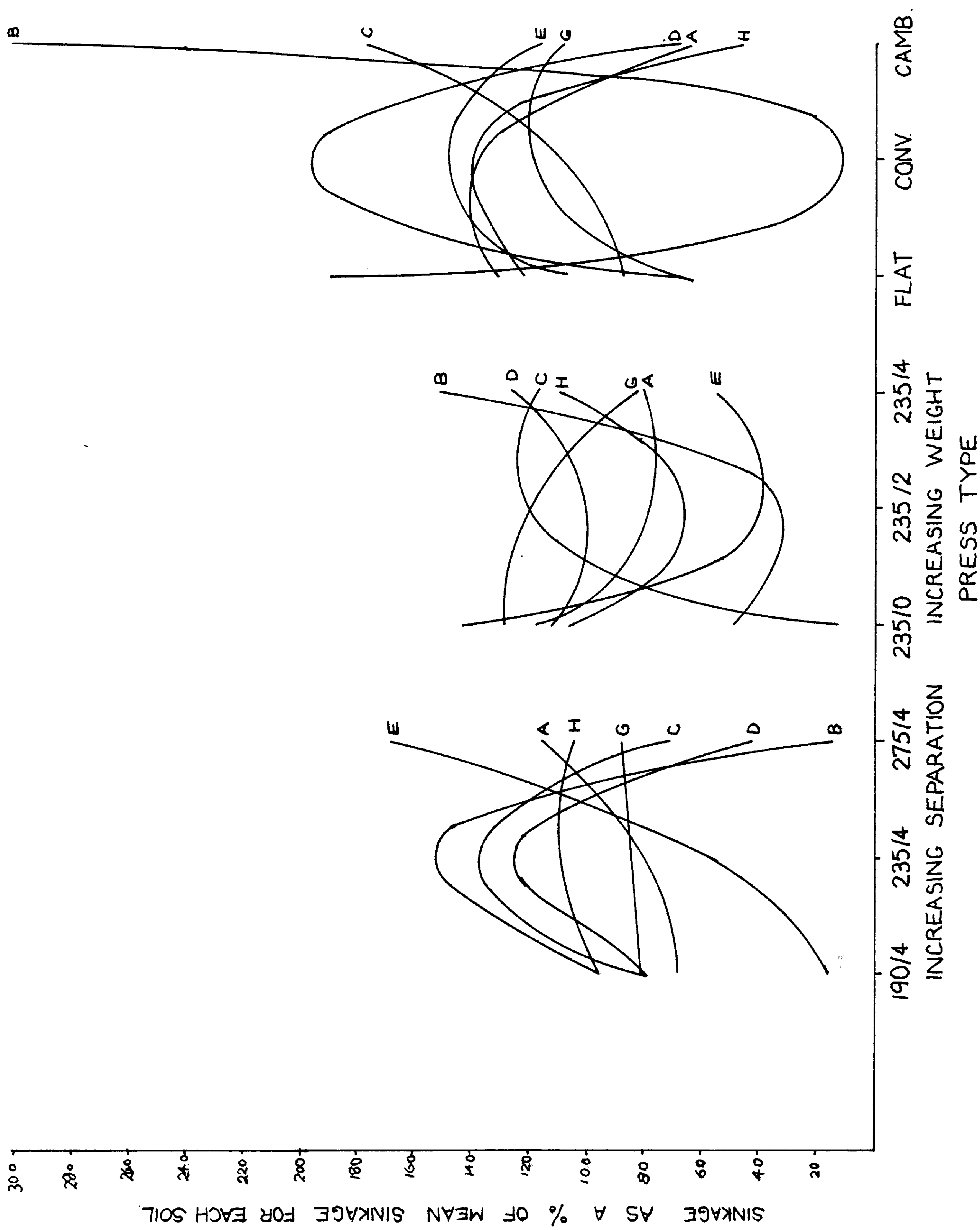


Fig 6.3.3 Sinkage after pressing for different presses

6.4 DISSCUSSION

6.4.1 Clod Size

In order to ensure that each photograph was given an equal opportunity they were presented unmarked to ten people who each placed them in order of clod size reduction, compared to a control for that soil type. These results gave an average, and most people had less than three pictures out of position from the average. In tests carried out at random, each persons repeatability was found to be in the order of 100%, ie one person would arrange the photographs in the same order twice, with a time delay between the tests.

The rankings were calculated to give a mean and standard deviation. Using these figures, and a Student t - distribution (sample size less than 30) upper and lower confidence limits were established at a 95% confidence level. These results are graphed in Fig 6.3.2. To provide an answer to which press was the best of all, on average, the upper limits and the lower limits were each summed to give an upper and lower limit for a total (Fig 6.3.1 and Table 6.3.1).

From this, it can be seen that the 190mm spacing, 690kg and the 235mm, 690kg presses performed significantly better than the others. The 190 spacing being slightly better (Fig 6.4.1) if the best results for the 235 spacings are taken, ie. changing weight to suit conditions, then the results are very close.

a) CONVENTIONAL PRESS - SOIL C

b) 190/4 COMBINATION PRESS - SOIL C

Fig 6.4.1 The best reduction in clod size

The flat roller arrangement, on some soils appeared to perform better in the photographs than observed in the field, but studying the pictures, the surface produced seemed to be very fine. The probable reason for this is that the flat surface produced obviously has no relief, therefore no clods can be seen on a photograph. In the field, the roller was tending to roll clods into the loose soil, but not reduce their size.

From the analysis of the photographs, it is evident that great care is necessary when taking the pictures. The position of the sun, field of view and direction from which they are taken are all extremely important, and must, as far as possible be kept constant.

6.4.2 Profiles and Sinkage

The profiles produced by all the presses were reasonably level, and much less pronounced than those obtained in the soil bin. There were no significant differences between runs, or between soil types. Surface profile can be easily misinterpreted, and two profiles may look the same, but may be totally different. In one case a very compact, level seedbed might have been produced, or alternatively, a loose uncompacted surface may have been left, and neither can be distinguished from its profile.

The results obtained from the sinkage measurements must be taken as guidance only, since during further analysis a possible error in the experimental technique has been observed. The amount of sinkage occurring might be dependant upon where the wheeling was, relative to the furrow slice or furrow bottom, a factor which was not under control

The results from the sinkage measurements do however show a number of trends. The graphs of sinkage as a percentage of the mean (Fig 6.3.3) demonstrate this more clearly. In 5 out of 7 cases, the minimum spacing produced the least sinkage. A possible explanation is that the 190/4 arrangement acted as a single roller, and produced a more compact surface layer. At a wider spacing, the presses produce bigger ridges with bigger furrows, and consequently the tractor sinkage was greater.

At the widest spacing, the rings begin to act as single feet, producing a downward compaction and not dilating the surface as much, therefore providing a stronger soil, and less sinkage. Depending upon the soil type this pattern occurs within the range tested or outside it.

Again, in 5 out of 7 cases, minimum sinkage occurred at the medium weight level. This backs up the predictions made from the Soil Bin, ie. that too much weight will produce a weaker surface because of greater sinkage. The exact position of the optimum weight depended upon the soil type and condition but was in the region of 500-600kg, or approximately 100kg per large ring.

There was no real pattern to the remaining three arrangements, the flat combination, the conventional press and the cambridge roller. In most cases, the conventional press produced the most sinkage, except in soils B and C. Only soils B and G had lower sinkages in this group than with the angled combination presses, the conventional for B and the roller for G.

The best arrangements in terms of clod breaking were with narrow and medium ring combinations and a spacing of between 190 and 235mm. A weight level of around 100kg per large ring was found to be the best on most soils but could be advantageously changed on some soils.

Combinations using a flat roll produced a more level surface but did not produce much clod reduction.

SECTION 7 : EFFECTS OF SPEED ON FURROW PRESSING

7.1 Objectives

With the advent of modern, high horsepower, four wheel drive tractors, ploughing speeds have dramatically increased. This is particularly so on lighter land, where the use of a furrow press is more common, and speeds of 8 mile/h or more are not unusual. Work conducted by Culpin (1937) stated that the degree of compaction occurring under a flat roller decreased with increasing speed. To discover whether this was true for presses, the following experiments were conducted.

7.2 Methodology

Two groups of experiments were conducted, the first using a press alone on previously ploughed land at different speeds. The latter used a plough and press together at different speeds.

The first attempt was made using a fully randomised block design with five speeds (2,4,6,8 and 10 mile/h) and three replications. In practice it proved impossible to accelerate and decelerate fast enough to get all five speeds close enough together to be on a comparable piece of land.

Another attempt was made, this time using just two speeds (3 & 13 km/h) per run with an acceleration area, and then decelerating to the second speed.

When it was felt by the driver that the desired speed had been reached, a signal was given, and a stake placed in the ground beside the press axle. The run was then timed until approximately 15m had been covered when a second marker was placed and the timing stopped. Measuring the distance allowed the speed to be accurately calculated. The first experiment was conducted on a Sandy Loam Soil (72% Sand, 13% Clay, 15% Silt) and the second on a Sandy Soil (90% Sand, 3% Clay, 7% Silt). A single row press was used, using six medium rings at a spacing of 190mm.

7.3 Results and Observations

In the first series of experiments using the press only at different speeds, no visible difference could be detected. The profiles were virtually identical. Results obtained from the penetrometer using both the cone and plate showed no significant differences between treatments. There were also no significant differences between the bulk densities obtained throughout the profile between 25 and 150mm across the treatments. There was a reduction in the density of the top 25mm as speed increased of about 6%.

The experiments conducted using a plough and press together again demonstrated very few differences. With the faster treatments, the surface finish was slightly more level compared to the slower ones. Both cone and plate penetrometer tests showed no significant differences between treatments, compared to the differences between replications. There was a reduction in bulk density of the surface layers (top 25mm) as speed increased, of about 5.5% as shown in Table 7.2.1. There were again no significant differences between bulk densities at depths greater than 25mm.

Speed (km/h)	Surface Bulk Density (kg/m^3)		
	Press Only	Plough and Press	% Reduction
3	1287	1212	5.8%
13	1204	1138	5.5%

Table 7.2.1 Decrease in surface bulk density with speed.

7.4 Discussion

The reduction in surface bulk density was caused by the rings sinking in past their shoulders. Due to the spoked design of the rings, the soil which falls onto the back of the ring gets picked up and dropped onto the soil surface. The faster the rings rotate, the further up the soil gets before falling and so the surface density is reduced.

If a press with solid sides were used this problem could possibly be removed and there would be no detrimental effects of high speed ploughing, other than increased mechanical wear and tear.

At present care must be exercised when pressing sandy soils to ensure a firm surface layer is produced, especially in areas where wind or water erosion are common.

SECTION 8 : ANGLED PRESS WHEELS

8.1 Objectives

It was thought that a double axle furrow press, with each gang angled might improve clod breakage, by having a shearing effect, together with a compressive effect. This series of experiments was conducted to investigate the action of an angled press in basic terms.

8.2 Methodology

A standard double axle furrow press frame was used, and drilled to allow the axles to move to give included angles of 5°, 10°, 15° and 20° (Fig 8.2.1).

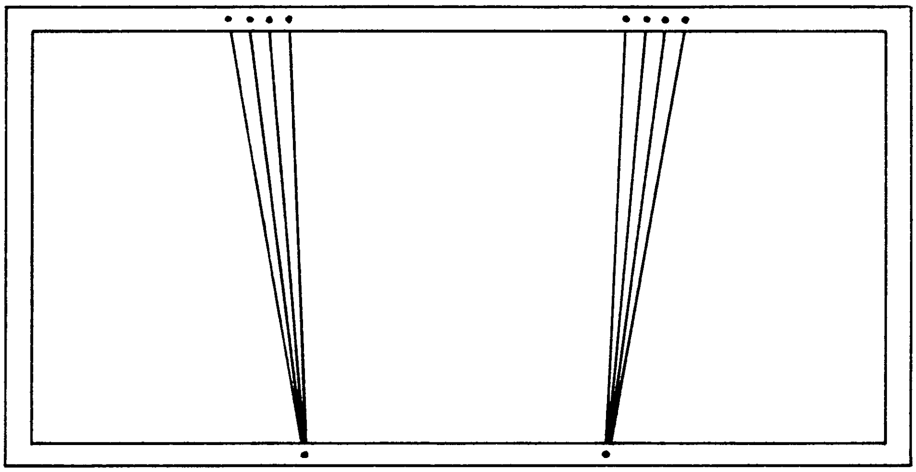


Fig 8.2.1 Angles used on the double axle press.

Three medium weight rings (50mm wide, 34° included angle, 700mm diameter, 54kg) were used on each axle. For the first three tests, spacings of 150, 190 and 380mm on each axle were used. The rings on the front axle were positioned centrally, and the rear ones offset by half the spacing.

For the angled work, the chosen spacing was 190mm, and the positions on the axles were left unchanged as the axles were angled.

All this work was conducted in the Silsoe College Soil Bin, the same procedure being used as described in Section 5.2. Profiles and penetration resistance were recorded and as a final experiment, clods were added into a box of soil set in the soil bin. These clods were cylindrical in shape, 150mm long and 75mm diameter. They were extruded from clay using a pug mill and allowed to air dry for one week before being sealed in plastic bags. They were built up in different patterns (Fig 8.2.2) and packed around with soil bin soil.

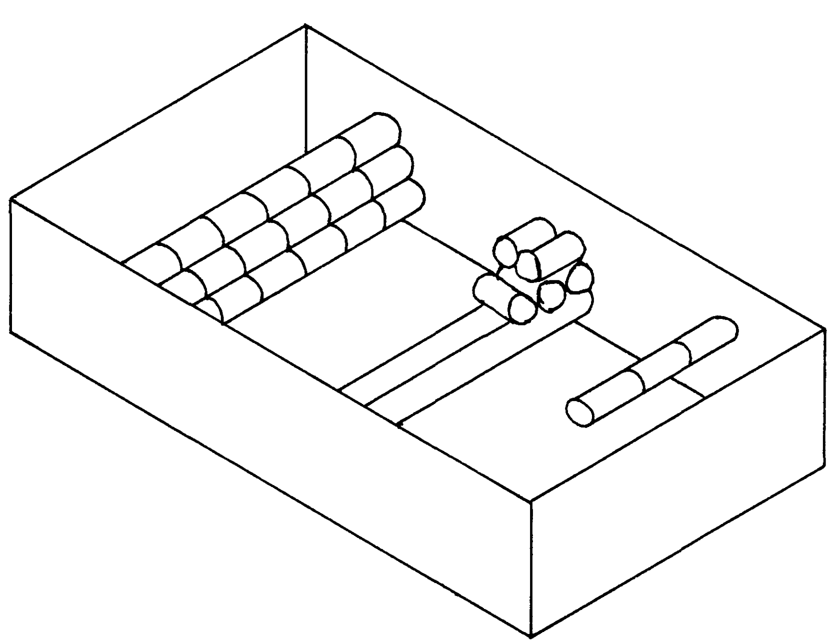


Fig 8.2.2 Stacking arrangements for clods in the soil bin.

8.3 Results and Observations

The results are given in Appendix VIII and a summary of the average compactions is given in Table 8.3.1.

Angle	0°			5°	10°	15°	20°
Spacing	150mm	190mm	380mm		190mm		
Depth							
0 - 60mm	0	8	8	3	0	8	7
50 - 120mm	283	323	239	222	134	196	133
120 - 180mm	1337	1304	960	1294	1021	963	799
Average	540	545	402	507	385	389	313

Table 8.3.1 Penetration Resistance Averages for different spacings and angles (kN/m^2)

The surface profiles left by the presses showed no significant differences. Those produced by the angled treatments had a very loose ridge left, similar to a ridge left by a disc plough.

8.4 Discussion

8.4.1 Penetrometer Results

A comparison of the three parallel axled presses, shows that there is little difference between 150mm and 190mm, spacings. At a spacing of 2x190mm (ie. 380mm) compaction is greatly reduced to a point worse than a single axle press at 190mm spacing. There is no longer any interaction between the rings and consequently only limited areas are compacted.

As the angle between the gangs increase then the compaction decreases (especially in the 120 - 180mm layer) as shown in Fig 8.4.1 (a). This is due to the increase in area presented to the soil, ie. at 0° the soil is only acted upon by a small area of the press wheel, but as the angle increases, so soil is acted upon by a wider press wheel. The area presented was calculated by measuring the area from a scale drawing, assuming a sinkage of 100mm (Fig 8.4.3). A graph comparing penetration resistance at depth and the inverse of the presented area is given in Fig 8.4.2. There is an almost linear relationship between the two showing compaction at depth is inversely proportional to the area presented to the soil.

8.4.2 Clod Breaking

Further work is required to produce a useful technique for breaking clods in indoor conditions and clods of a lower clay content tested. No useable results came from the work conducted.

8.4.3 General

A gang angle of up to 5° could be used without causing a serious reduction in compaction if improved clod breaking resulted. At angles greater than 5° compaction is reduced markedly. If a similarly large increase in clod-breaking performance occured as gang angle increased then this situation might be of benefit. The reduction in compaction might be overcome by adding weight to the press to maintain the Weight/Area ratio. Further testing is required under field conditions.

For a parallel-axled double row press, a spacing on the axle of 190mm (95mm on the machine) gave the best results.

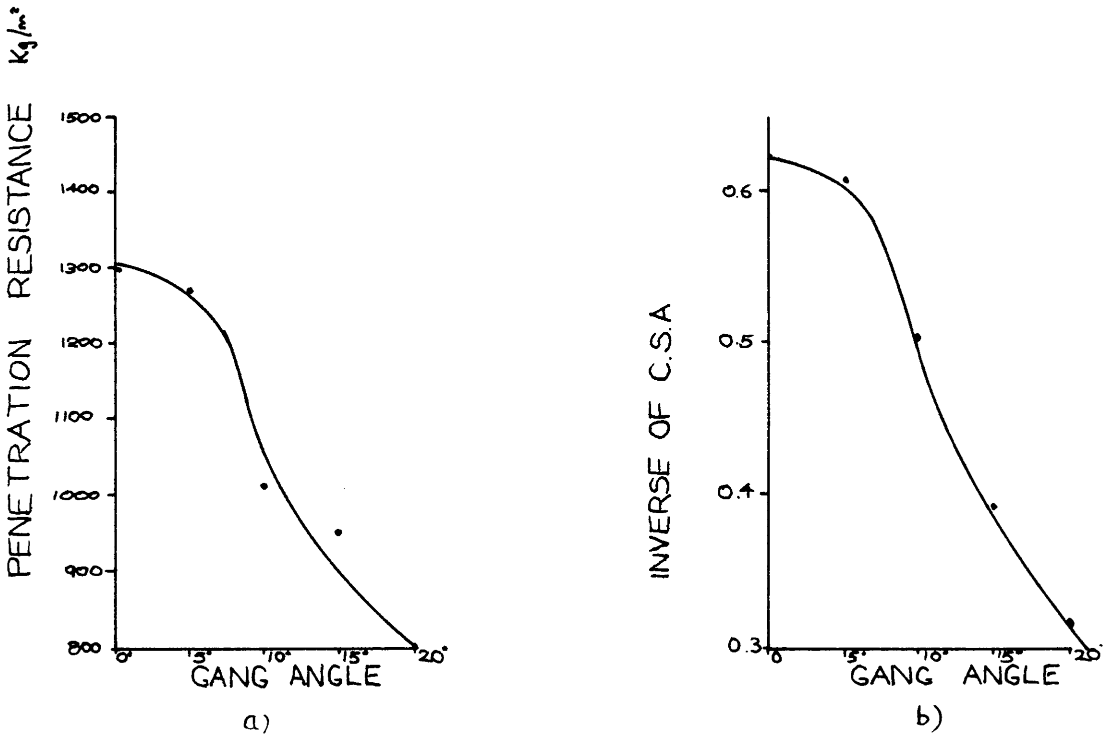


Fig 8.4.1 (a) Change in penetration Resistance with Gang Angle and (b) Inverse of Cross Sectional Area with Gang Angle.

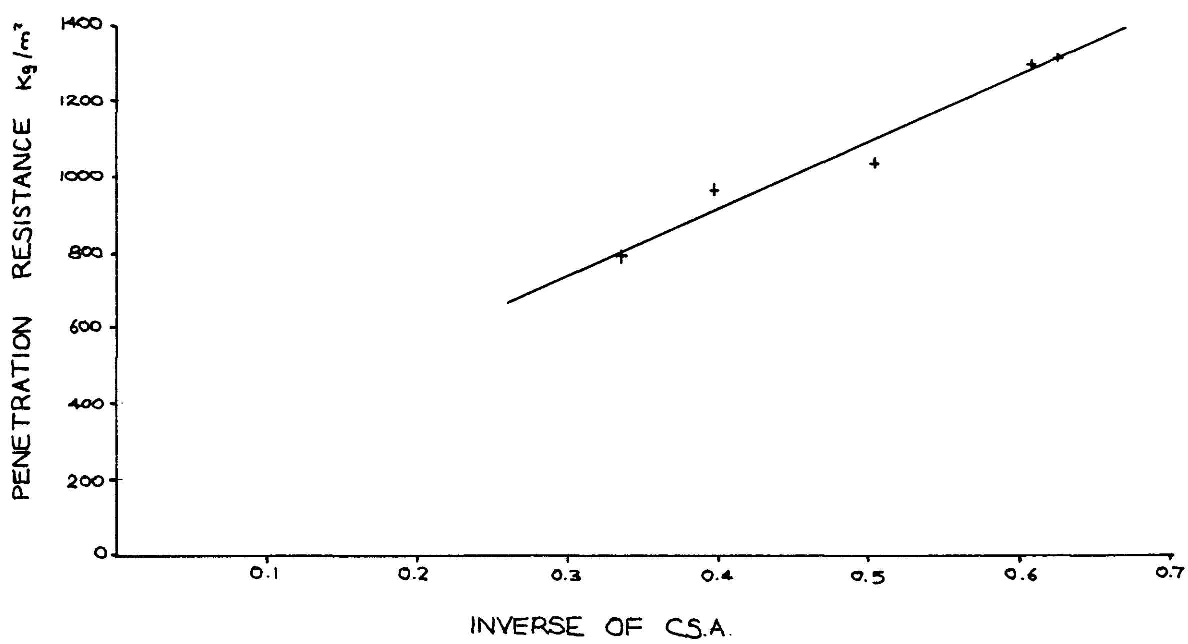


Fig 8.4.2 A graph of penetration resistance against the inverse of the projected area.

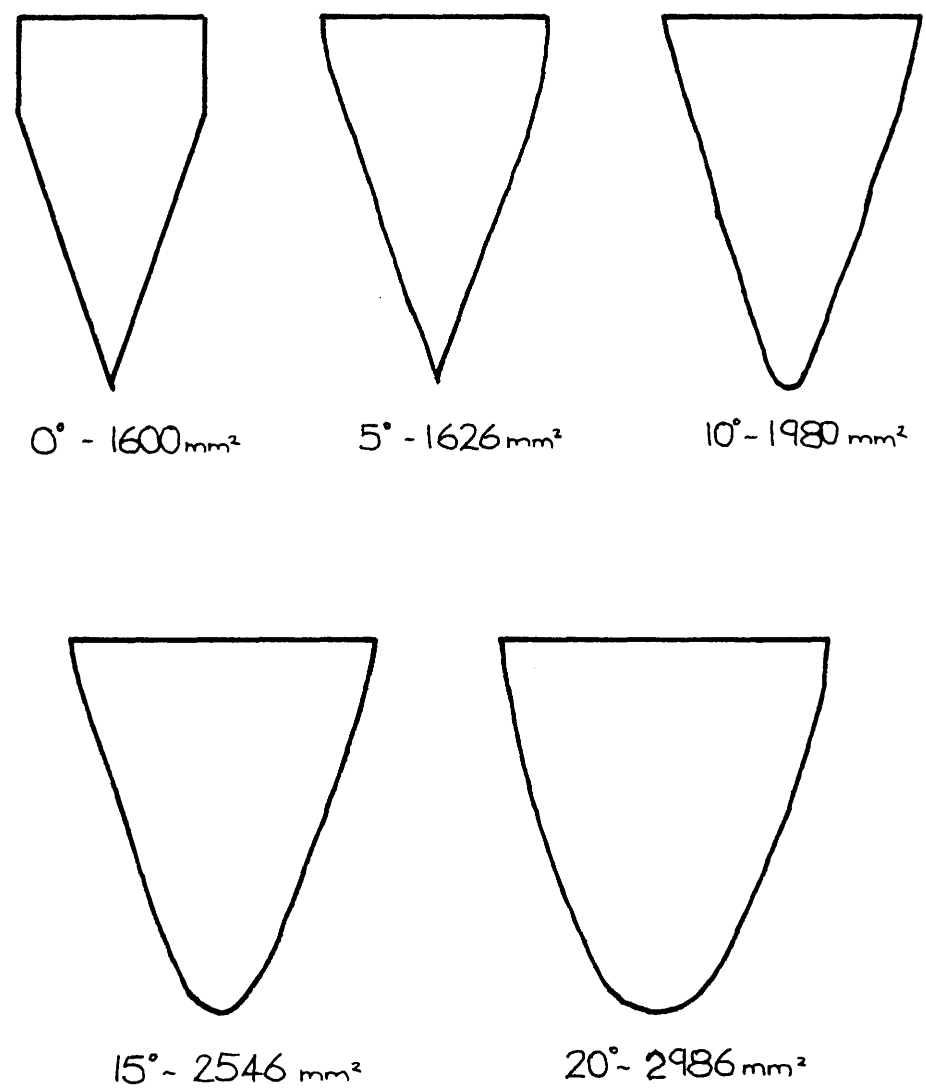


Fig 8.4.3 Change in Projected Area of a press wheel with gang angle.

SECTION 9 : CONCLUSIONS

i) Work conducted using sections of presses to break clods followed the failure model predicted by Ansell (1986). The best clod breaking was achieved using a medium profile (50mm wide, 34°) section between two narrow (25mm wide, 32°), a spacing of between 175-210mm and a difference in height of 40mm. Flat sections did not break clods very well.

ii) Increasing the included angle of a press wheel increases the force required to penetrate to a given depth. An angle of 30° produces almost only sideways movement compared to the predominately vertical movement using 180°. In order to achieve constraining forces small angles must be used. Shaped profiles tend to form slip planes from the tip to the shoulder, rather than for soil to flow along the shaped edge of the press.

iii) Soil bin tests on a full-scale press wheel showed a difference in diameter of 50mm gave the best results in terms of compaction throughout the profile. A critical weight level was found at which maximum compaction occurs. Above this weight, compaction in the 120-180mm layer continues to increase but at the cost of a reduction above that level. This critical weight varied depending upon the combination and spacing used, but was in general between 100kg and 140kg per large ring for the sandy loam soil used.

iv) From a clod breaking and soil finish point of view, an arrangement of 700mm and 650mm diameter wheels, alternatively on an axle with a spacing of between 190 and 235mm between the larger wheels gave the best results. In most cases, a weight of around 115kg/large ring gave the best result but on some soil types this could be advantageously reduced.

v) The speed at which pressing is performed was found to have little effect on the finished work. At the fastest speeds a slight reduction in surface bulk density occured, which was linked with a more level surface being produced.

vi) If a press is mounted at an angle to the normal direction of travel a reduction in compaction at depth occurs. This reduction is inversely proportioned to the increase in projected area of the press in the soil. An angle up to 5° has no serious effect on compaction.

9.2 General Conclusion

A press should be made using conventional narrow rings (700mm diameter) with a spacing of around 220mm, and 650mm diameter rings (34° included angle) between each large ring. The minimum effective weight should be around 80kg/large ring, with the ability to be increased to 120kg/large ring. This press should be effective on a wide range of soils.

For purely consolidation of light soils, the combination which gave the most even distribution of compaction used alternate 700mm narrow and 650mm diameter medium wheels and a spacing of 205mm, with a weight per large ring of around 70kg. The best tilth production on light soils was produced using either a cambridge roll or the combination using a spacing of 190mm and the same rings as above with a weight of around 120kg/large ring.

On stronger soils with a greater clay content, a wider spacing of 235mm and again a weight of around 120kg/large ring appeared to give better tilth production. Both clay soils gave a decreased sinkage at the maximum weight.

SECTION 10 : SUGGESTIONS FOR FURTHER WORK

i) Notched press wheels. The design of notches on a press wheel offers a very wide range of design possibilities such as shape, size, spacing, angles, curvature etc.

ii) Press wheels with deeper shoulders should be tested to see if the reduction in compaction with excess weight or speed can be prevented.

iii) Testing of an angled press under field conditions should be undertaken, to explore the clod-breaking abilities of such a machine.

REFERENCES

ANSELL, M.P. (1986). Investigations into the fundamental soil mechanics governing the behaviour of furrow presses. MSc Thesis, Silsoe College

CULPIN, C (1937). Studies on the relation between cultivation implements, soil structure and the crop. III rolls. Cambridge Jour. Agric Soc 27 432-446

DAÙDA, M (1986). An investigation into the effects of furrow press geometry on soil disturbance. MSc Thesis, Silsoe College

GODWIN, R.J. (1974). An investigation into the mechanics of narrow tines in frictional soils. PhD Thesis, Silsoe College

GODWIN, R.J. (1975). An extended octagonal ring for use in tillage studies. J Agric Engng Res, 20, 347-352

HETTIARATCHI, D.R.P. and O'CALLAGHAN, J.R. (1980). Mechanical behaviour of agricultural soils. J Agric Engng Res, 25 239-259

MEYERHOFF, G.G. (1961). Ultimate bearing capacity of wedge-shaped foundations. Proc 5th Int Conf on Soil Mechanics and Foundation Engng, Vol II. Div 3B, Dunod, Paris

SANCHEZ-GIRON RENEDO, V (1985). An investigation into the behaviour of furrow presses. MSc Thesis, Silsoe College

WONG, J and REECE, A.R. (1967). Prediction of rigid wheel performance based on the analysis of soil-wheel stresses Part 1: Performance of driven rigid wheels. J of Terramechanics 4 (I), pp 81-98

APPENDIX I

CLOD BREAKING RESULTS

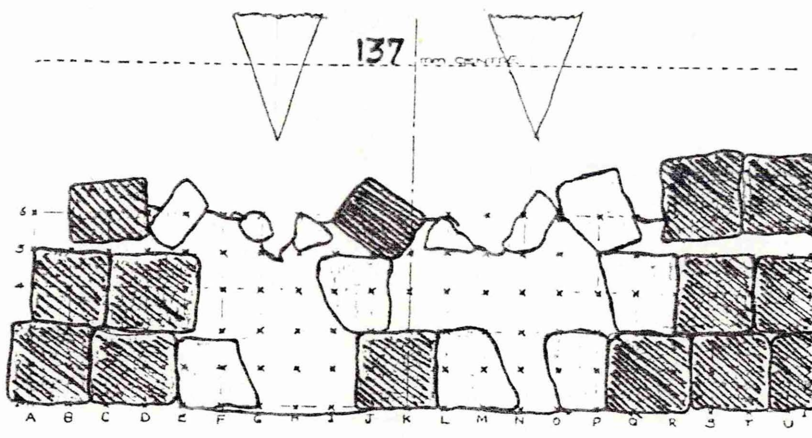
a) Two medium feet at : 137mm, 205mm and 272mm spacing

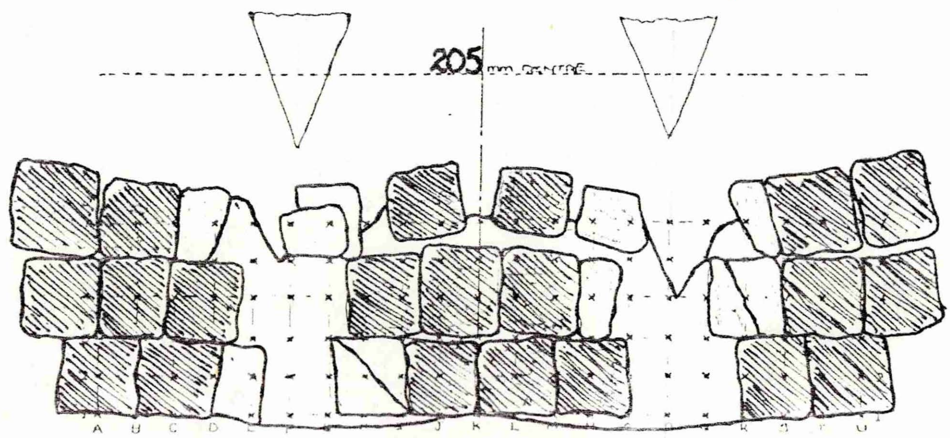
b) Two medium and one wide foot, different spacings and lags

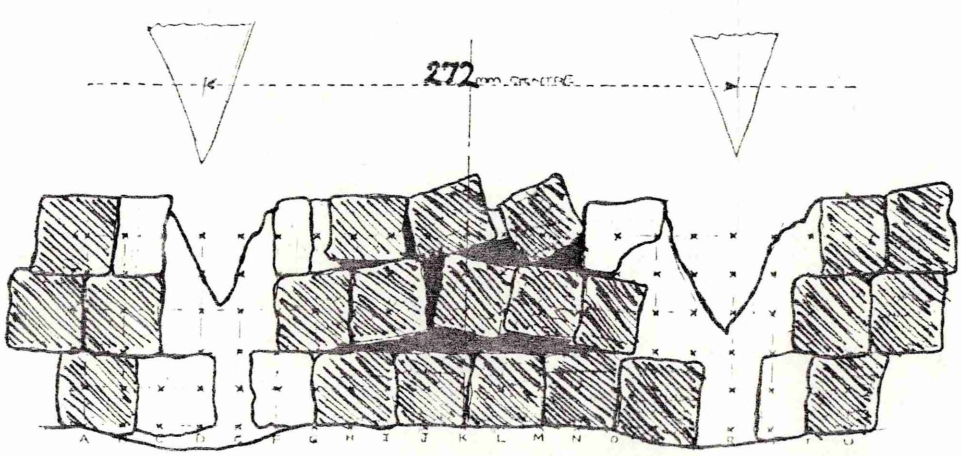
c) Different combinations

d) Two narrow and one medium feet at : 137mm, 175mm and 205mm spacing, 40mm lag

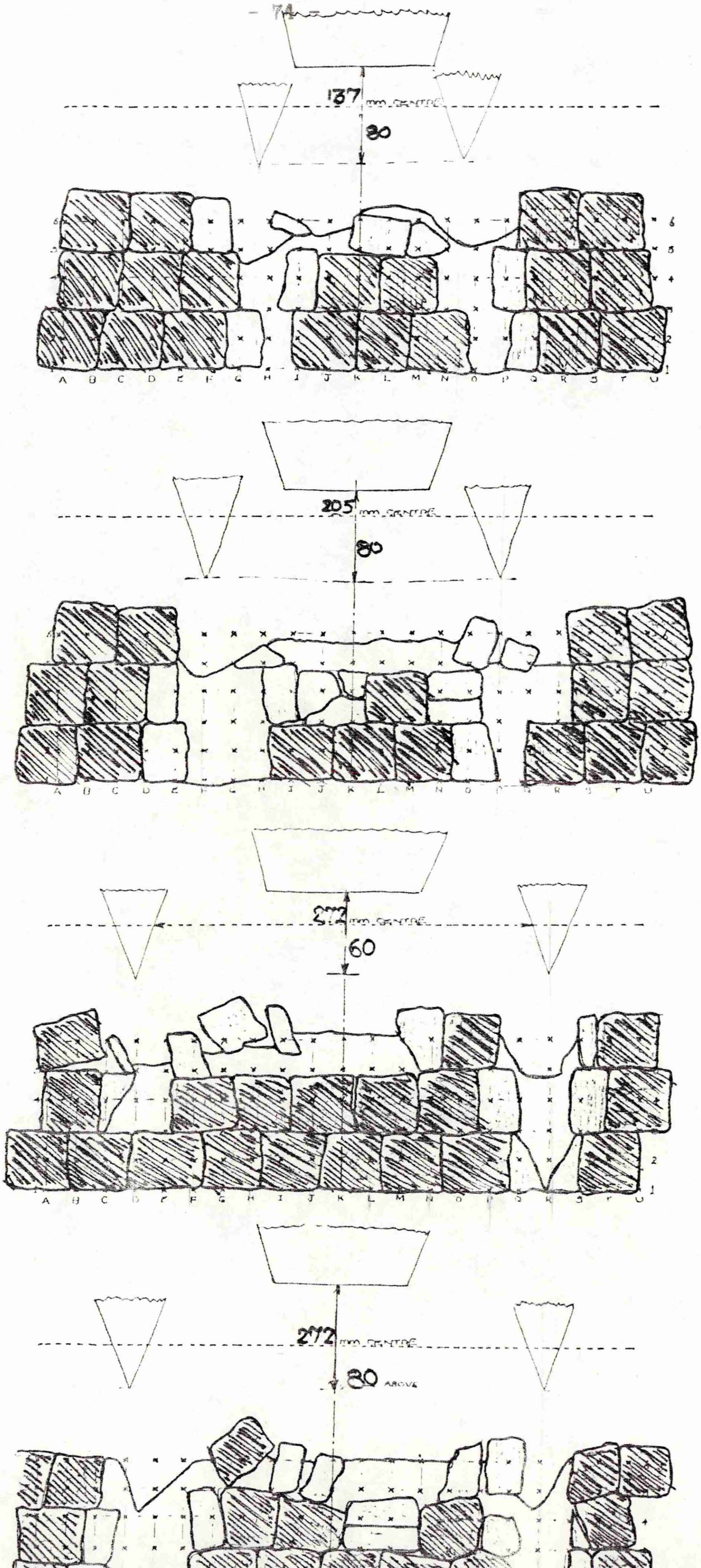
e) Two narrow and one medium, 175mm spacing, 0, 20mm, 40mm and 60mm lag


137 mm CENTRE
A B C D E F G H I J K L M N O P Q R S T U

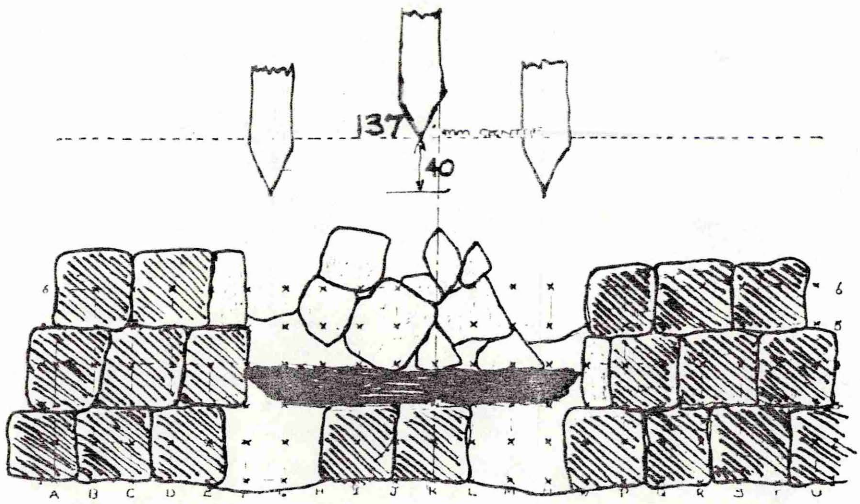

205 mm CENTRE

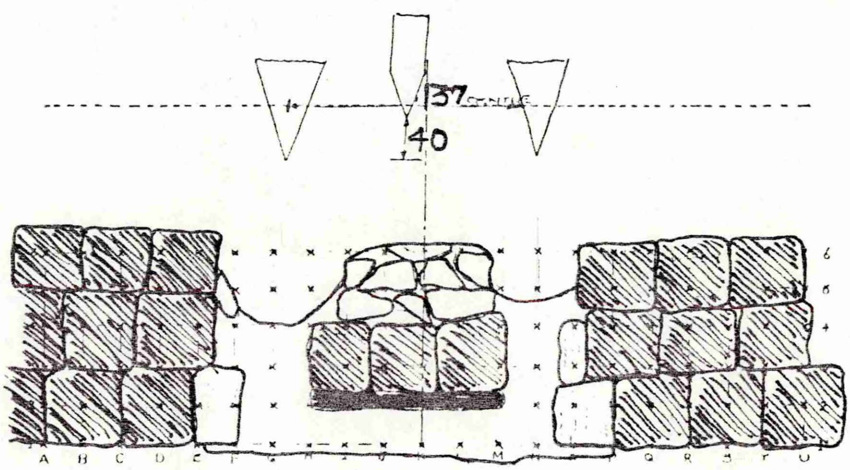

272 mm CENTRE

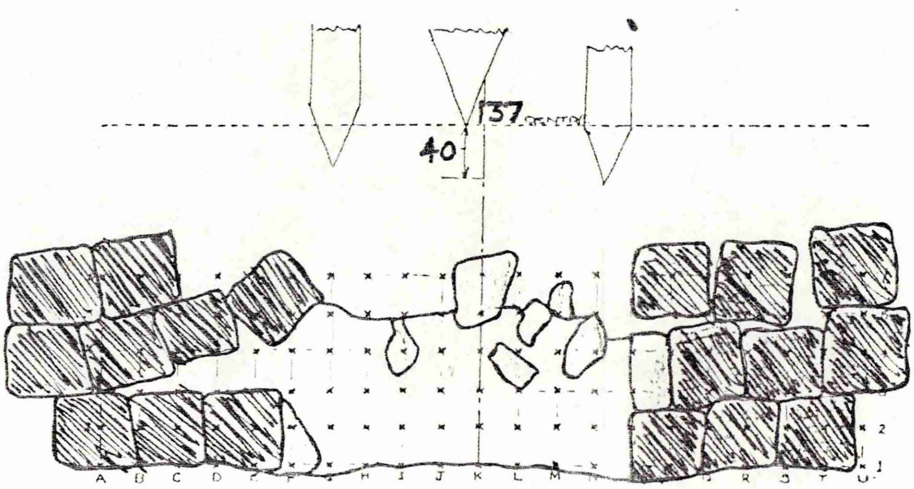
(a)


137 mm CENTRE
80
A B C D E F G H I J K L M N O P Q R S T U
205 mm CENTRE
80
A B C D E F G H I J K L M N O P Q R S T U
272 mm CENTRE
60
A B C D E F G H I J K L M N O P Q R S T U
272 mm CENTRE
80 ABOVE
A B C D E F G H I J K L M N O P Q R S T U

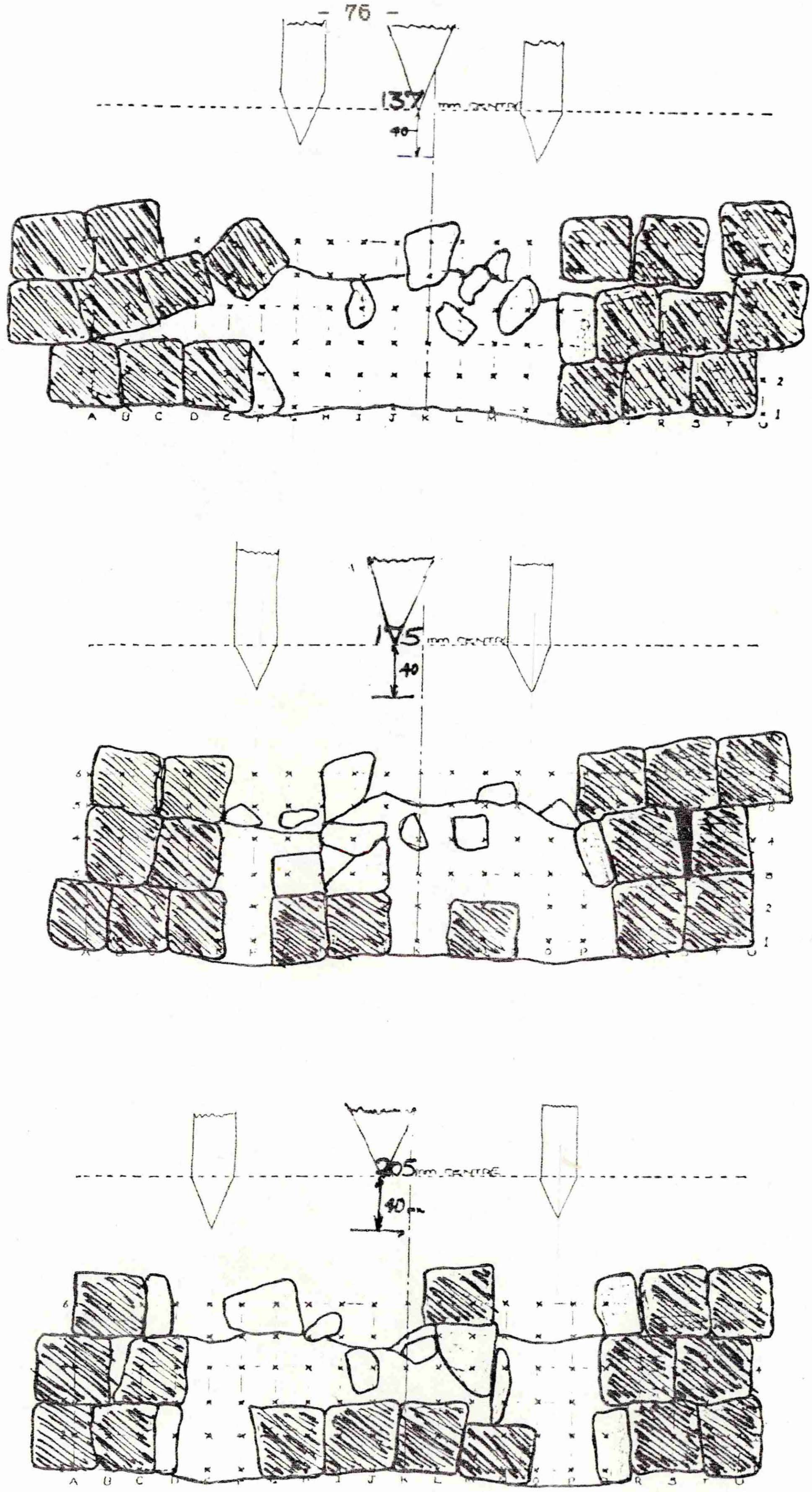
(b)



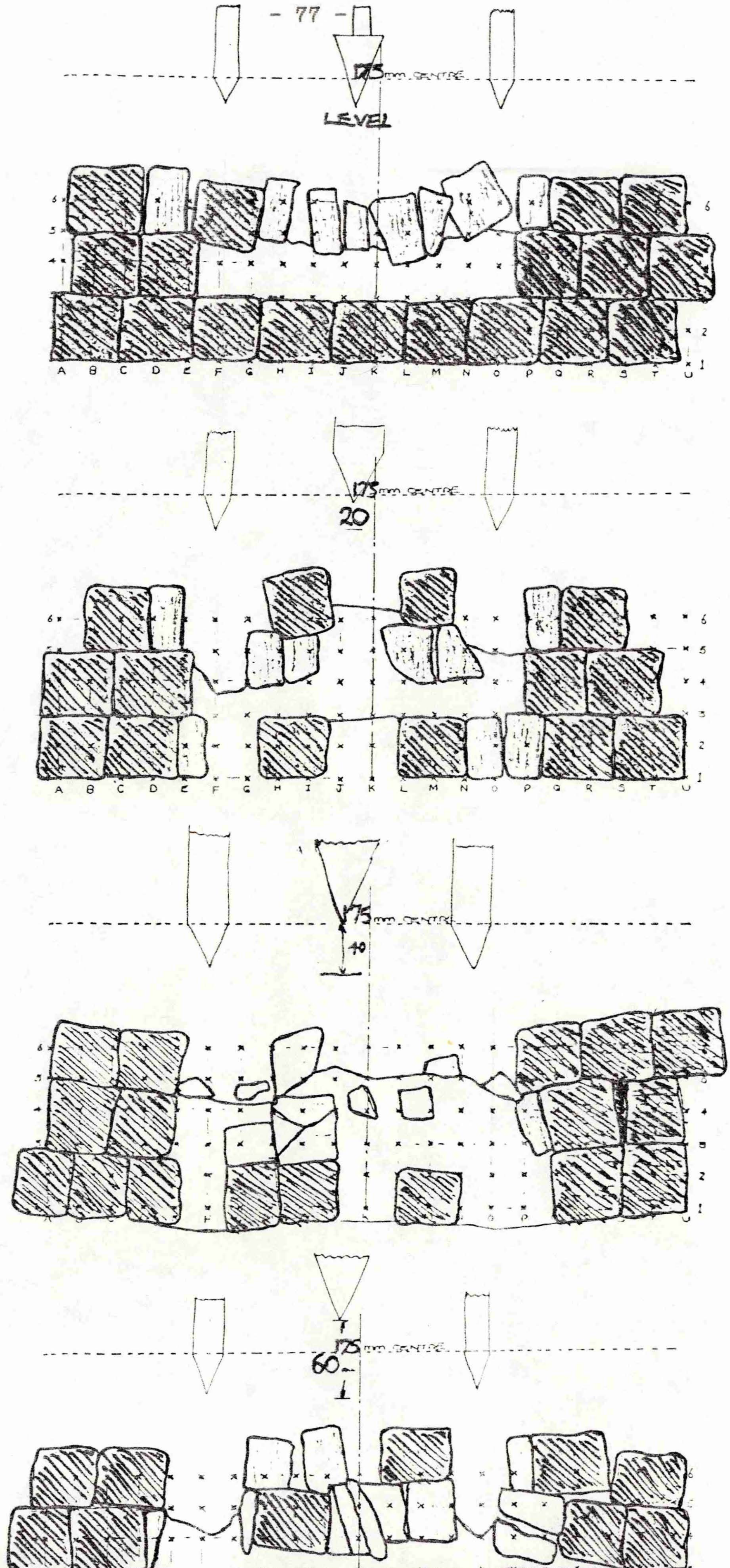




(c)



(d)


175mm CENTRE
LEVEL
A B C D E F G H I J K L M N O P Q R S T U
175mm CENTRE
20
A B C D E F G H I J K L M N O P Q R S T U
175mm CENTRE
40
175mm CENTRE
60
A B C D E F G H I J K L M N O P Q R S T U

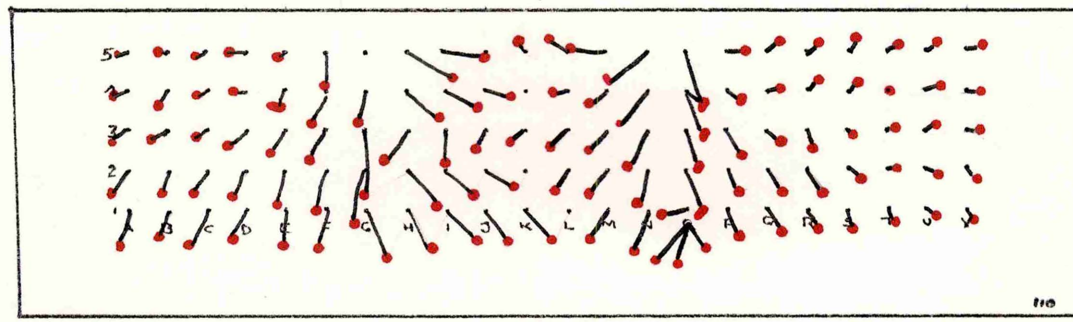
(e)

APPENDIX II

SOIL MOVEMENT FOR DIFFERENT ANGLED PRESS SECTIONS

a) 30°
b) 60°
c) 90°
d) 120°
e) 180°
f) Curved narrow
g) Curved wide
h) Combination

SOIL DISTURBANCE PATTERNS

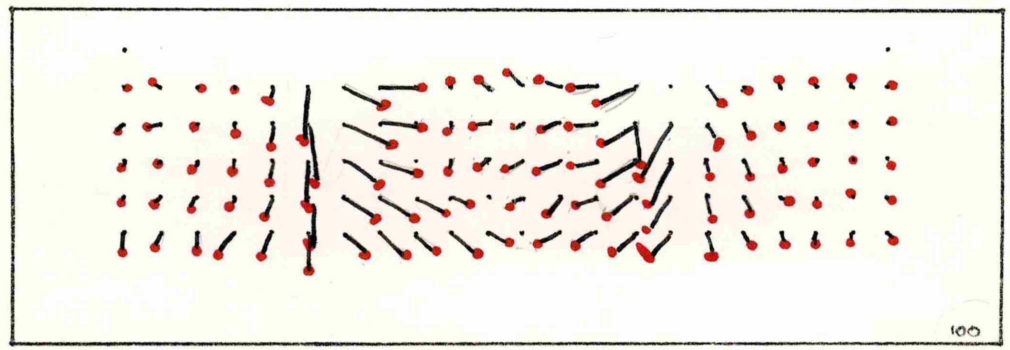


FEET TYPE : 30°

SPACING : NARROW

(a)

SOIL DISTURBANCE PATTERNS

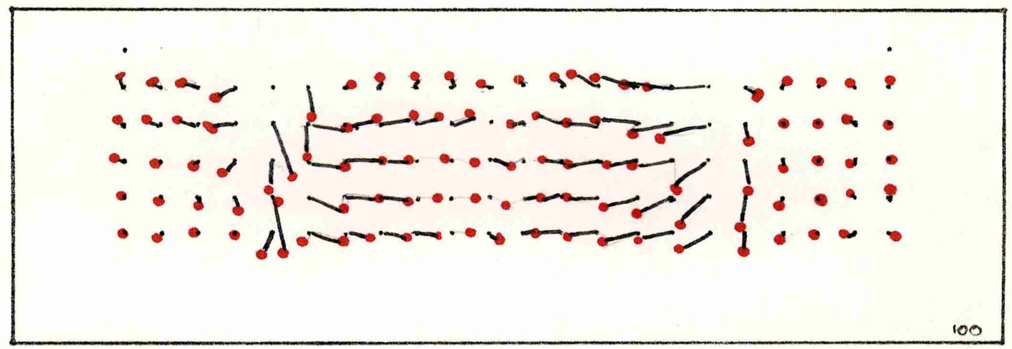


FEET TYPE : 30°

SPACING : MEDIUM.

(a)

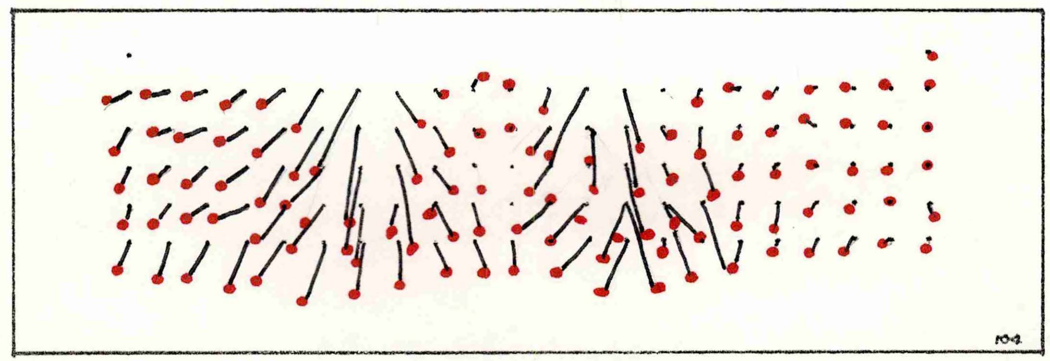
SOIL DISTURBANCE PATTERNS



FEET TYPE : 30°
SPACING : WIDE.

(a)

SOIL DISTURBANCE PATTERNS

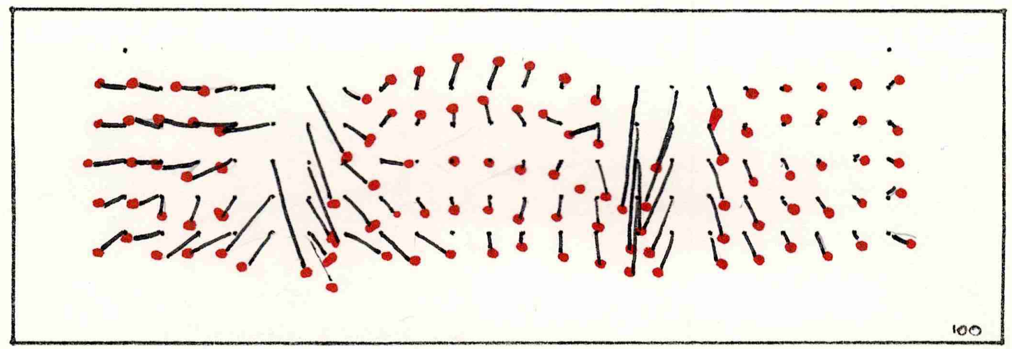


FEET TYPE : 60°

SPACING : NARROW.

(b)

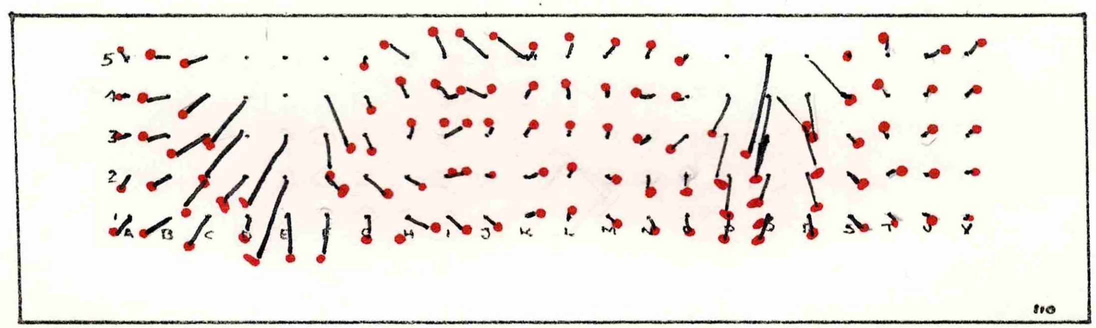
SOIL DISTURBANCE PATTERNS



FEET TYPE : 60°
SPACING : MEDIUM.

(b)

SOIL DISTURBANCE PATTERNS

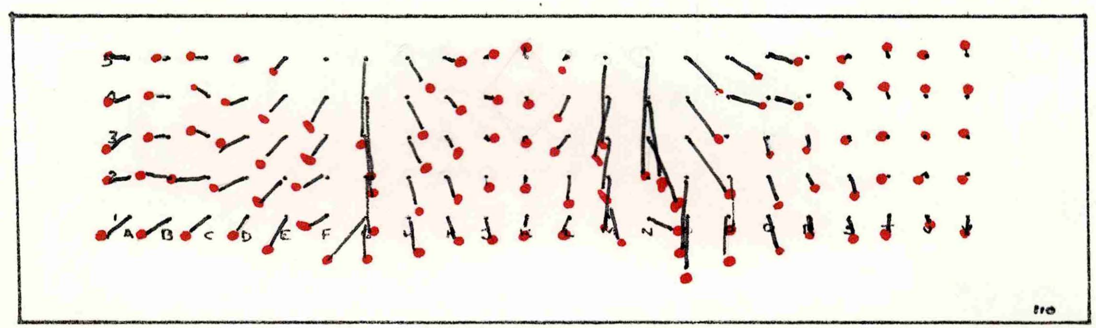


FEET TYPE : 60°

SPACING : WIDE.

(b)

SOIL DISTURBANCE PATTERNS

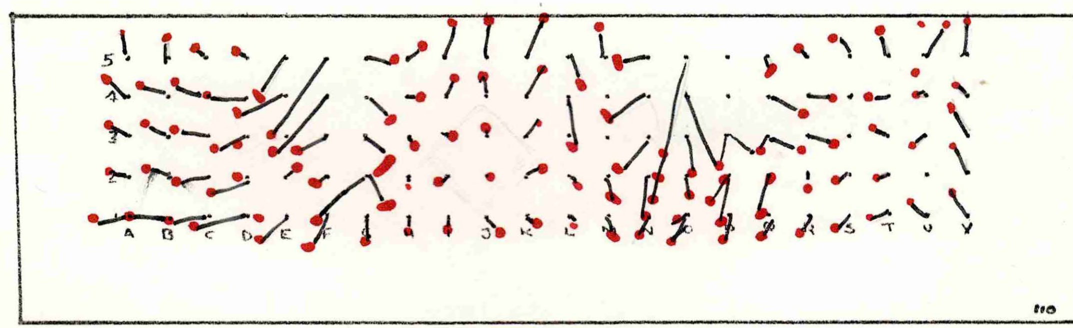


FEET TYPE : 90°

SPACING : NARROW.

(c)

SOIL DISTURBANCE PATTERNS

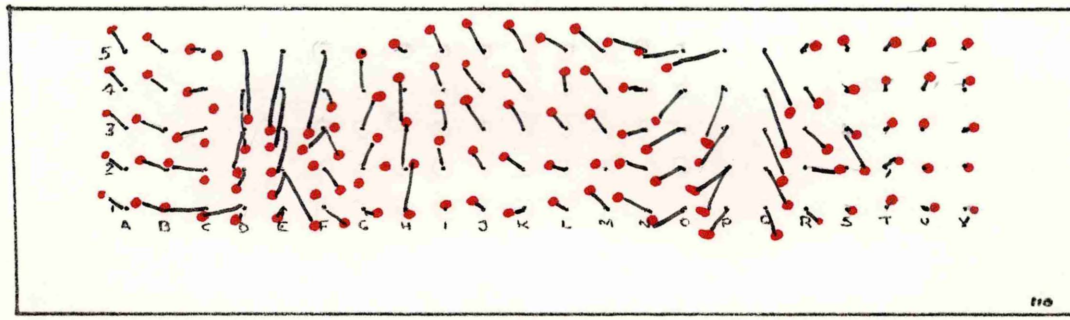


FEET TYPE : 90°

SPACING : MEDIUM.

(c)

SOIL DISTURBANCE PATTERNS

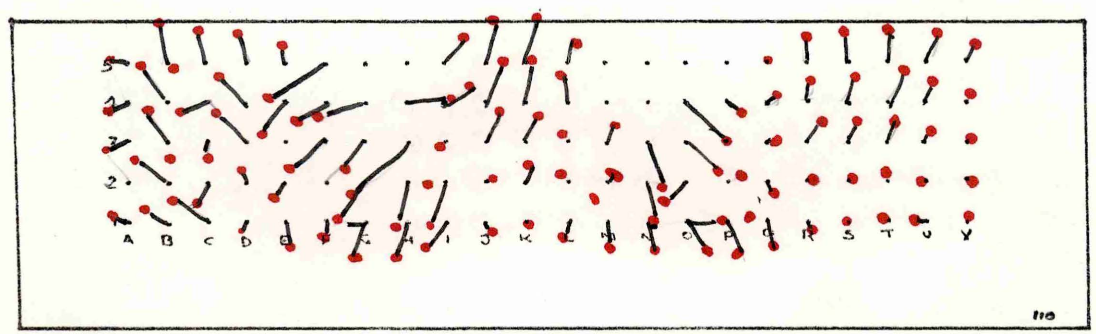


FEET TYPE : 90°

SPACING : WIDE.

(c)

SOIL DISTURBANCE PATTERNS

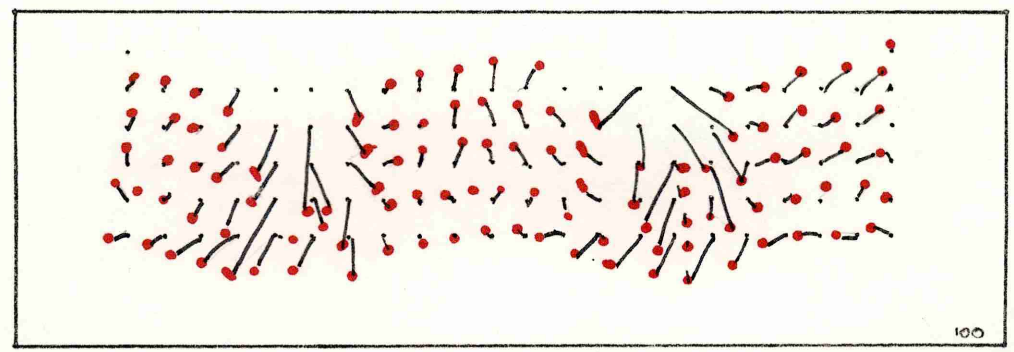


FEET TYPE : 120°

SPACING : NARROW.

(d)

SOIL DISTURBANCE PATTERNS

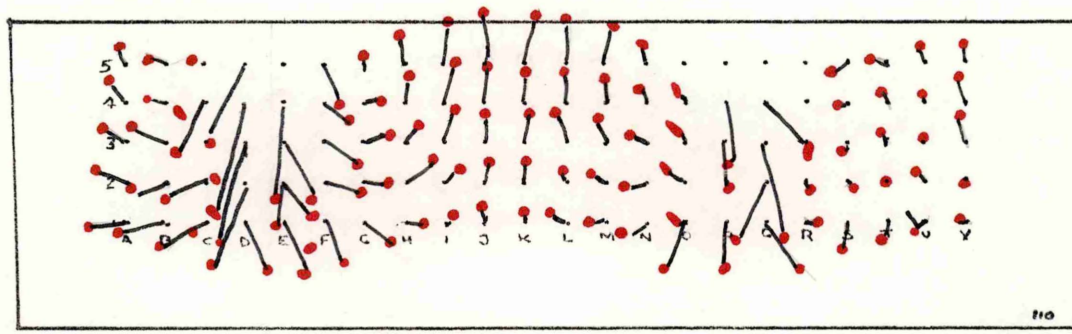


FEET TYPE : 120°

SPACING : MEDIUM.

(d)

SOIL DISTURBANCE PATTERNS

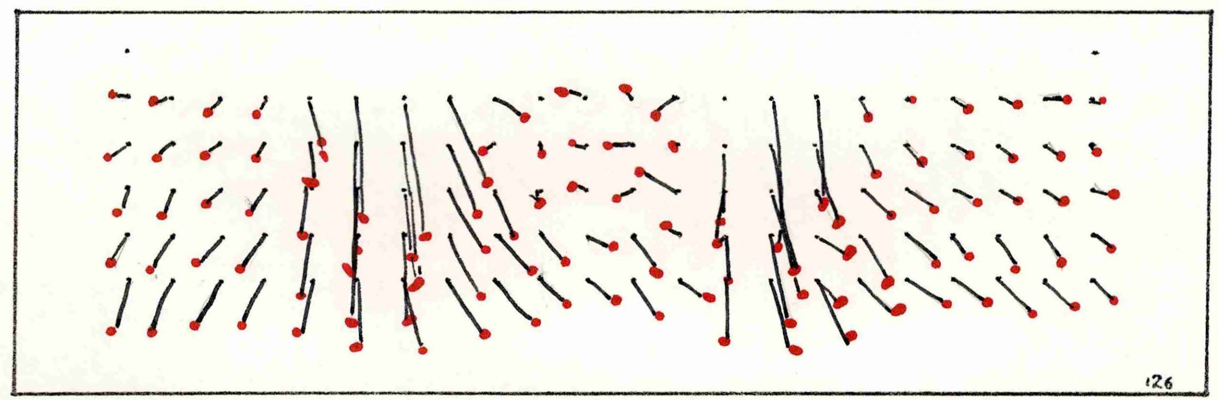


FEET TYPE : 120°

SPACING : WIDE.

(d)

SOIL DISTURBANCE PATTERNS

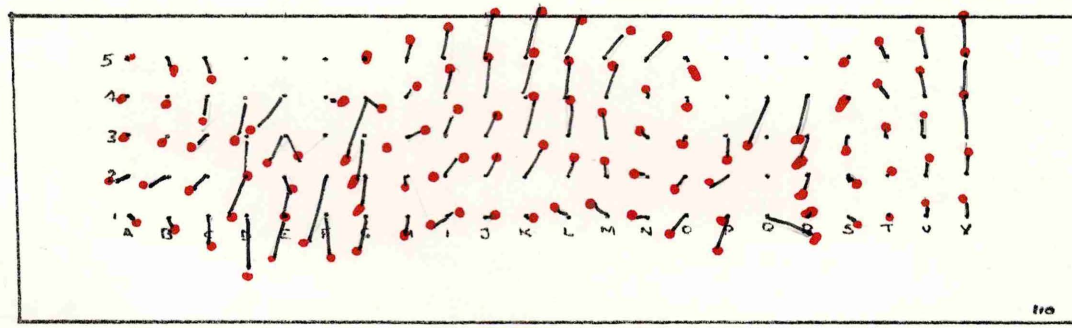


FEET TYPE: 30°

SPACING : NARROW

(e)

SOIL DISTURBANCE PATTERNS

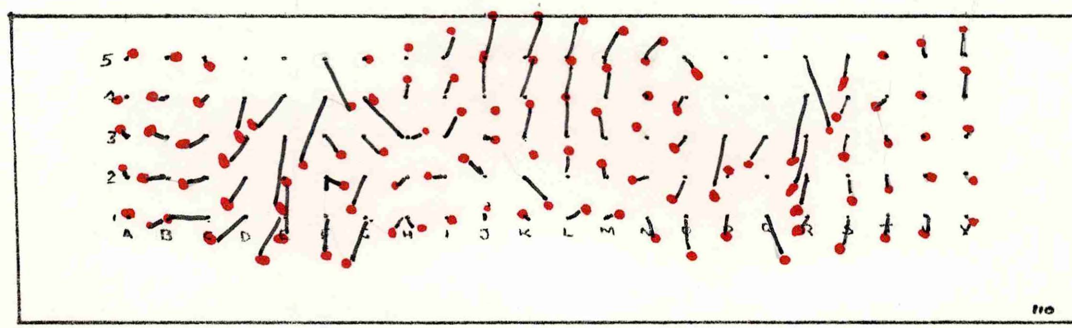


FEET TYPE : 180°

SPACING : MEDIUM.

(e)

SOIL DISTURBANCE PATTERNS

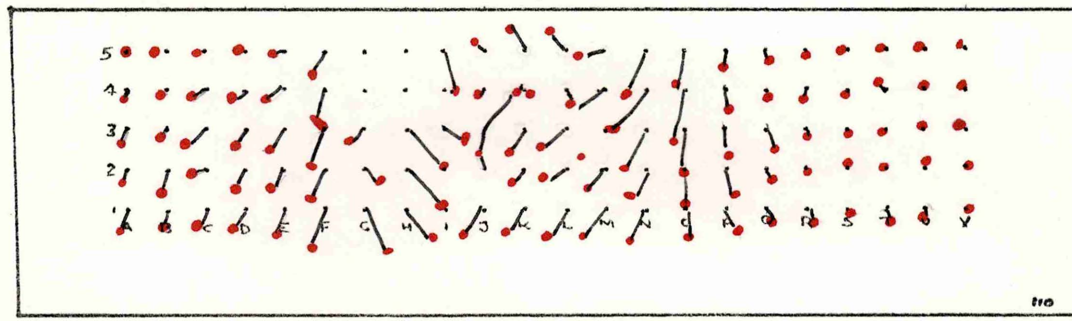


FEET TYPE : 180°

SPACING : WIDE.

(e)

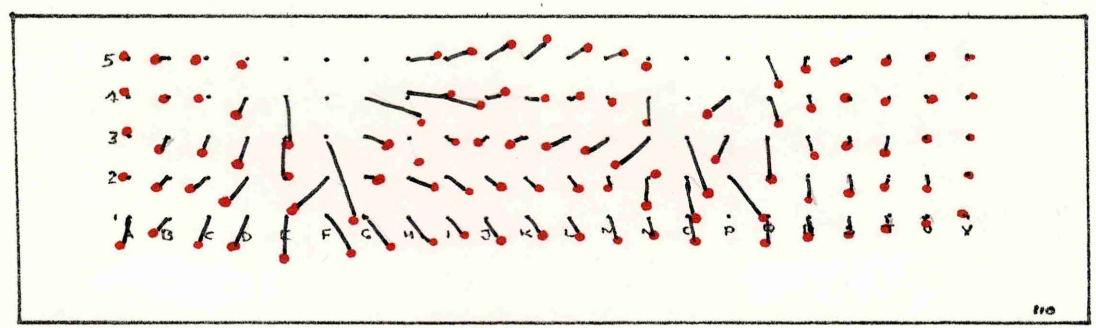
SOIL DISTURBANCE PATTERNS



FEET TYPE : CURVED -NARROW

SPACING : NARROW

SOIL DISTURBANCE PATTERNS

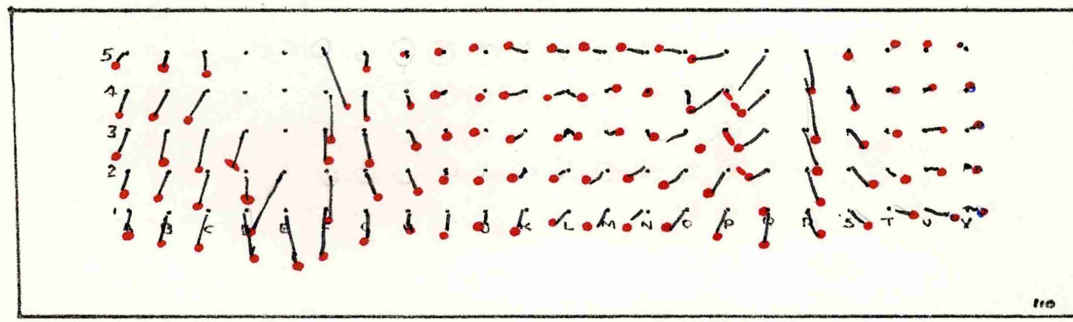


FEET TYPE : CURVED NARROW

SPACING : MEDIUM.

(f)

SOIL DISTURBANCE PATTERNS

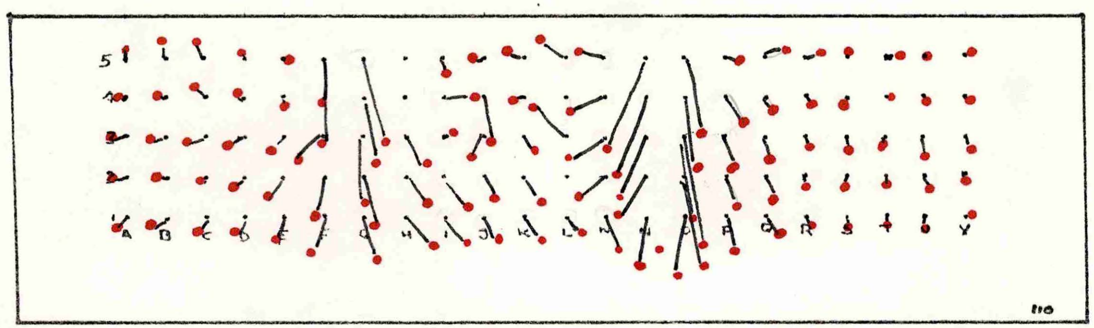


FEET TYPE : CURVED (NARROW)

SPACING : WIDE

(f)

SOIL DISTURBANCE PATTERNS

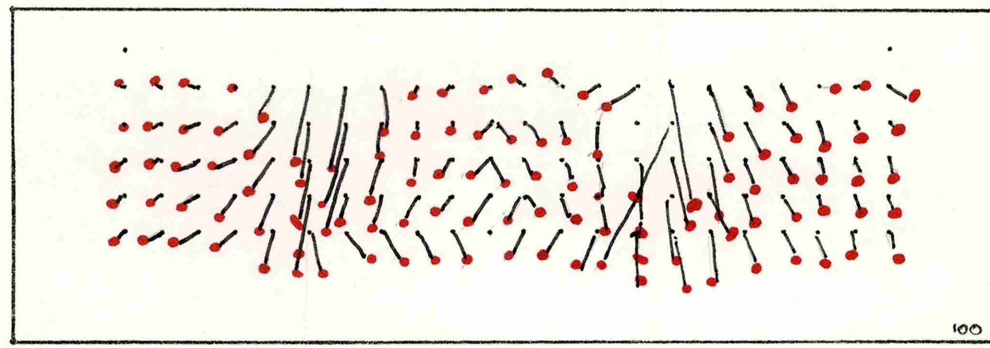


FEET TYPE : CURVED . WIDE

SPACING : NARROW.

(g)

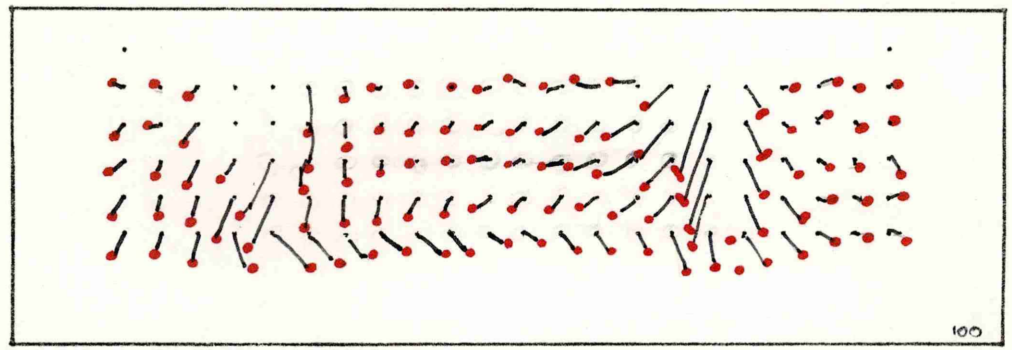
SOIL DISTURBANCE PATTERNS



FEET TYPE : CURVED - WIDE
SPACING : MEDIUM.

(g)

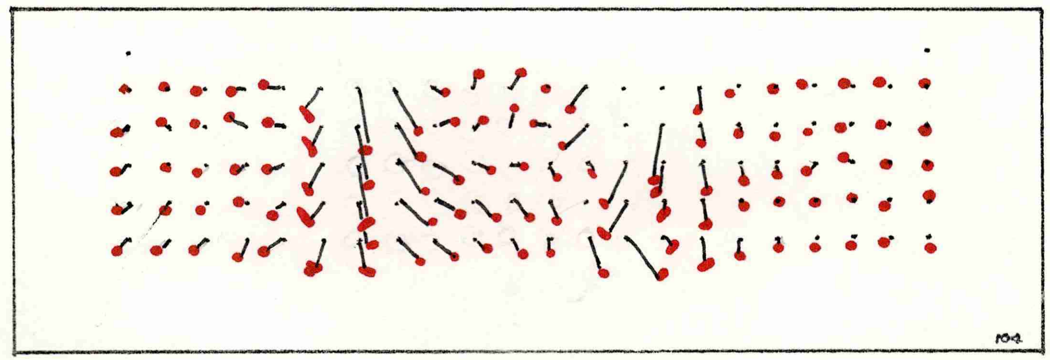
SOIL DISTURBANCE PATTERNS



FEET TYPE : CURVED . WIDE
SPACING : WIDE

(g)

SOIL DISTURBANCE PATTERNS

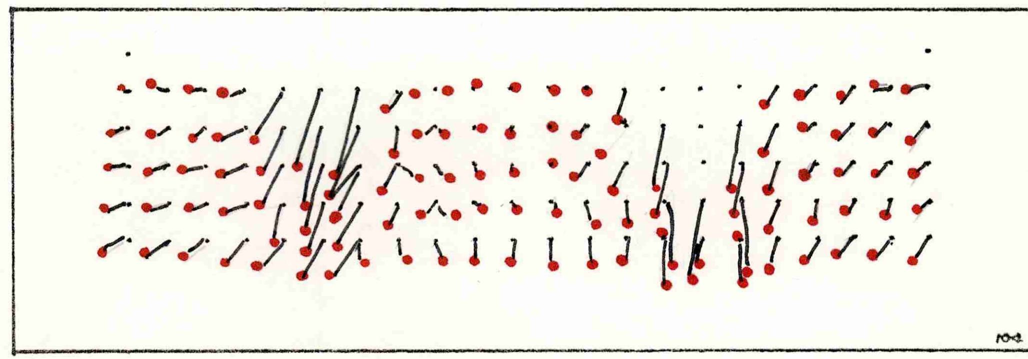


FEET TYPE : COMBINATION

SPACING : NARROW.

(h)

SOIL DISTURBANCE PATTERNS

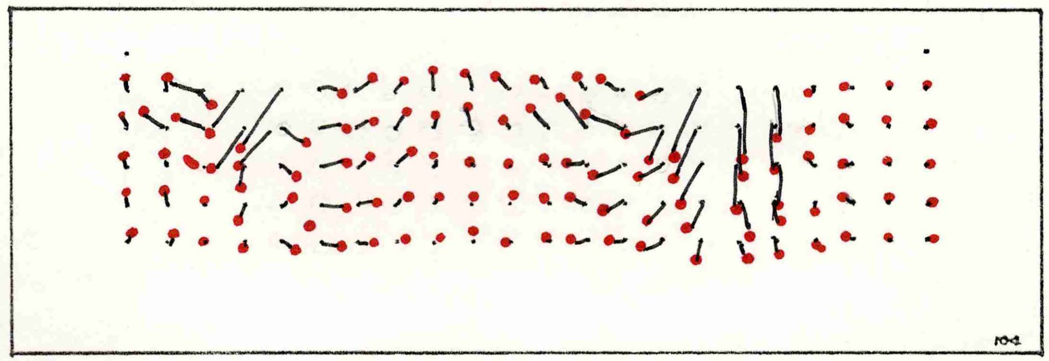


FEET TYPE : COMBINATION

SPACING : MEDIUM.

(h)

SOIL DISTURBANCE PATTERNS



FEET TYPE : COMBINATION

SPACING : WIDE.

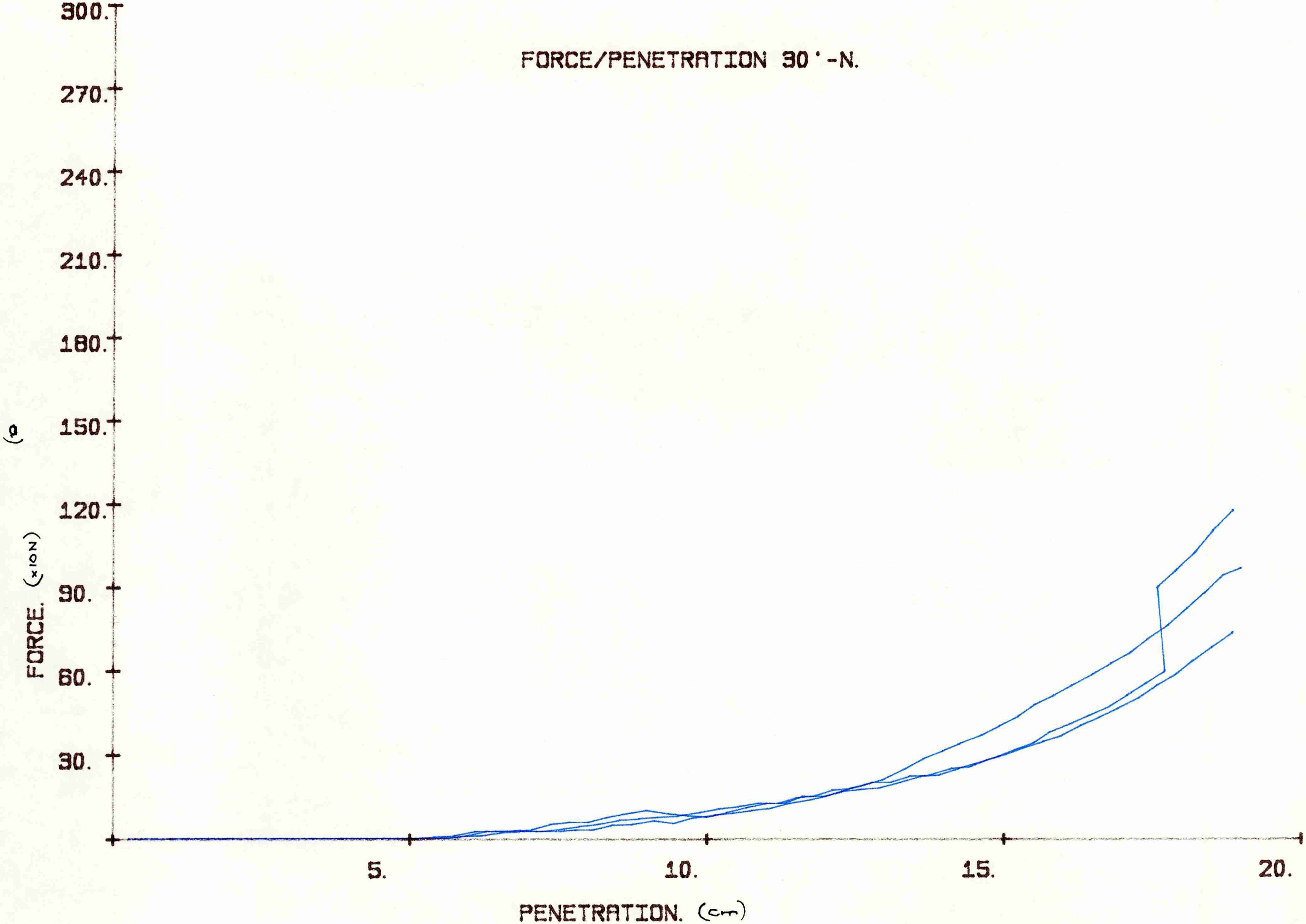
(h)

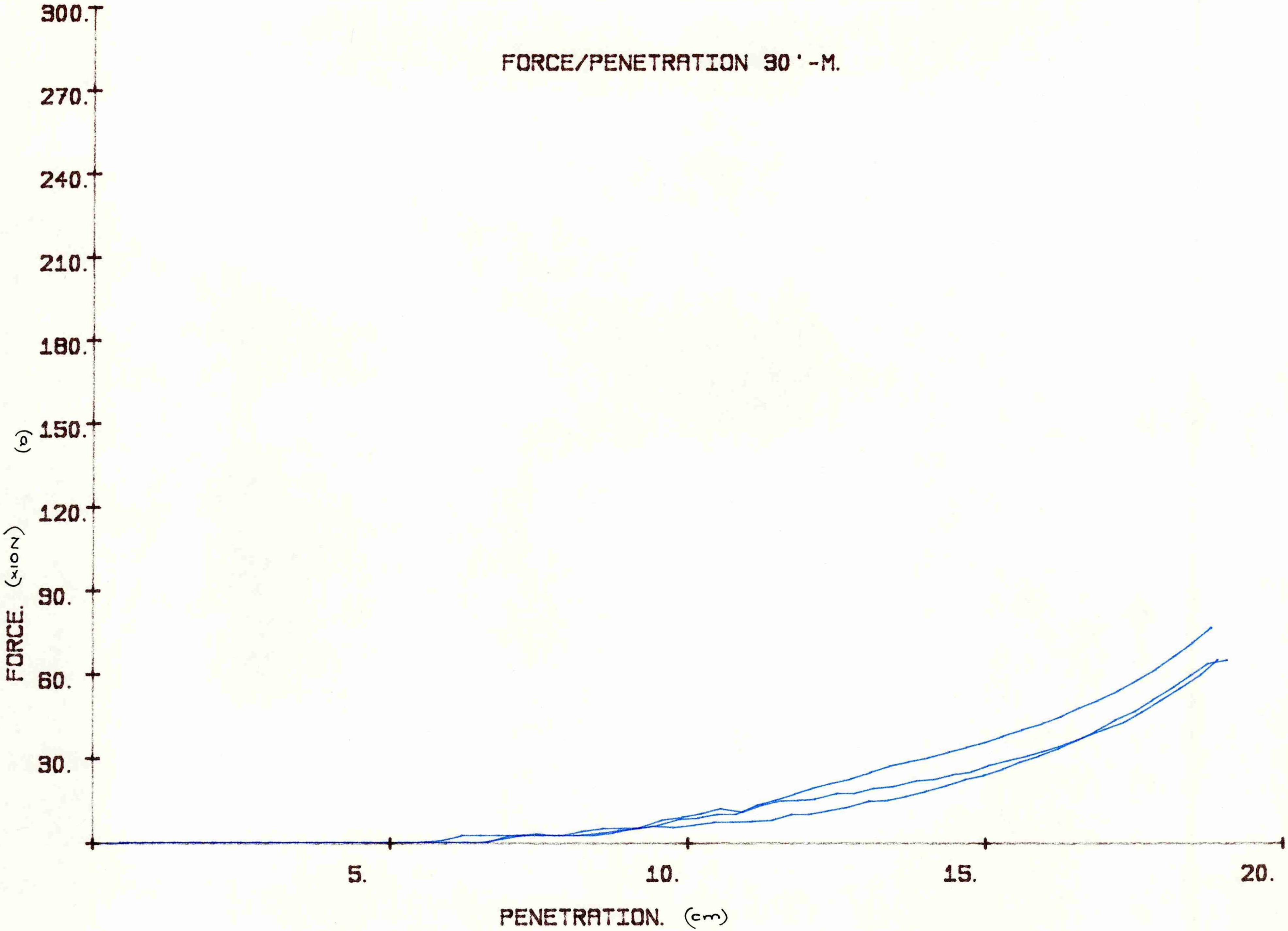
APPENDIX III

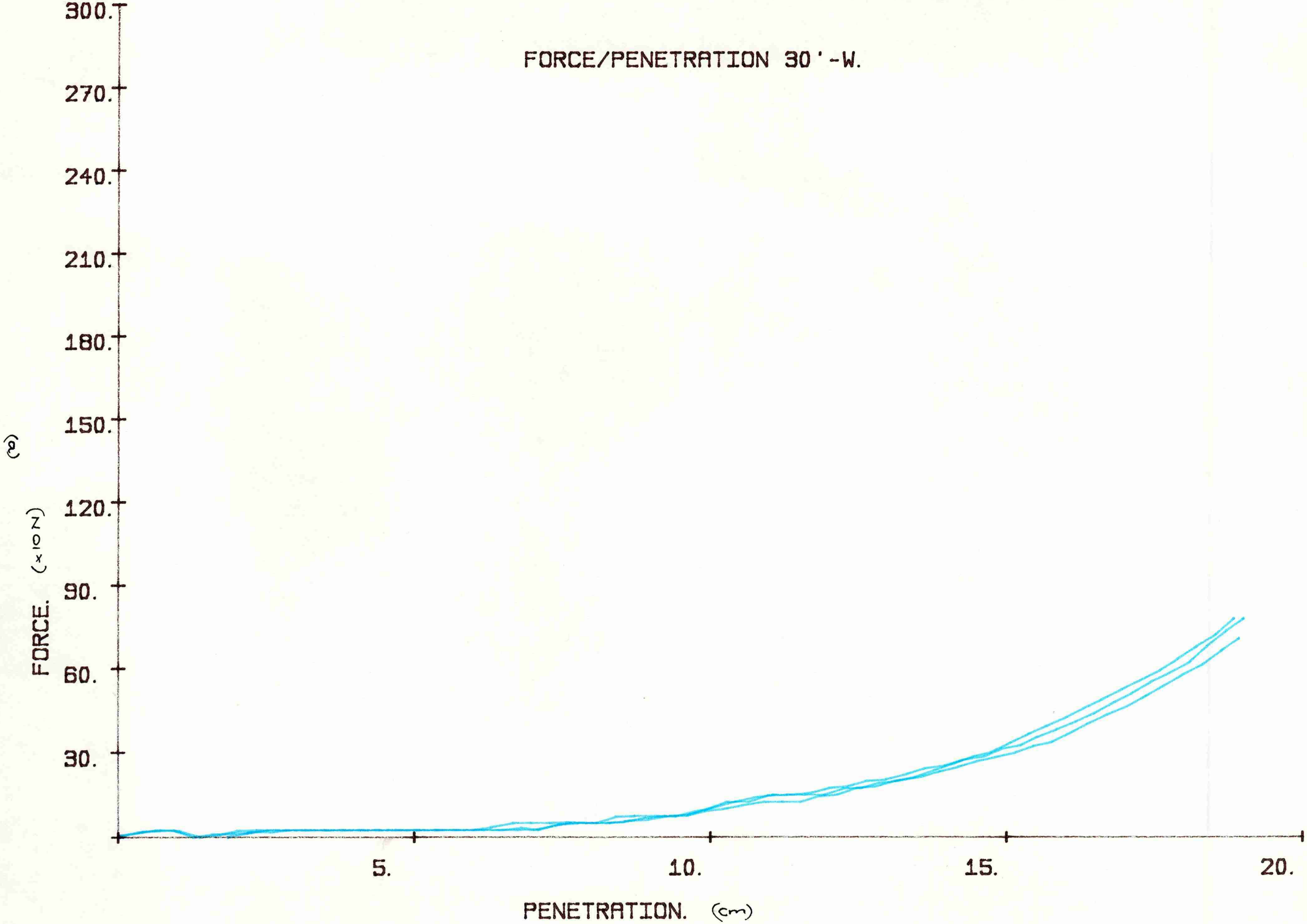
FORCE PENETRATION CURVES FOR DIFFERENT ANGLED PRESS SECTIONS

Each graph shows three replications

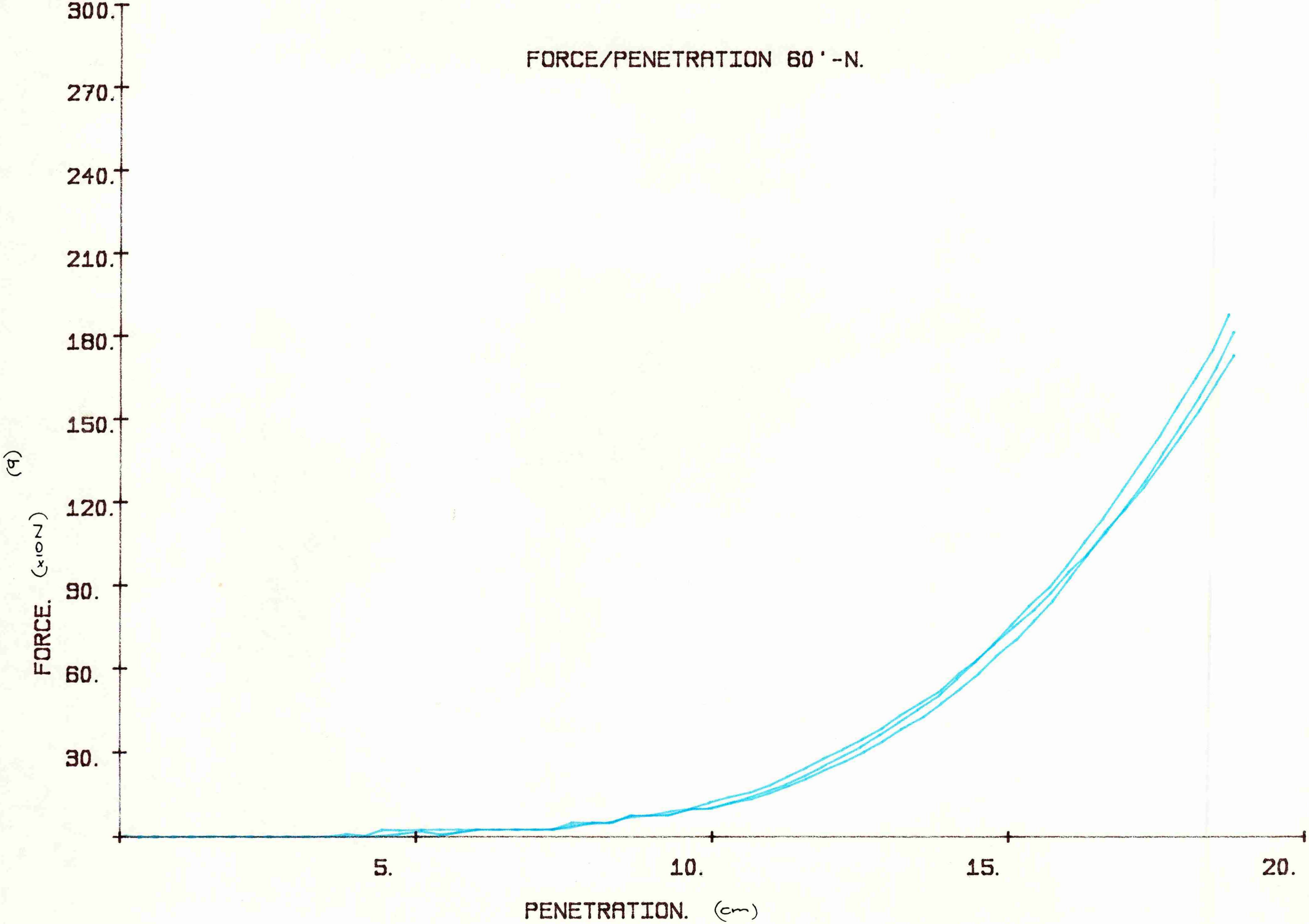
a) 30°
b) 60°
c) 90°
d) 120°
e) 180°
f) Curved narrow
g) Curved wide
h) Combination

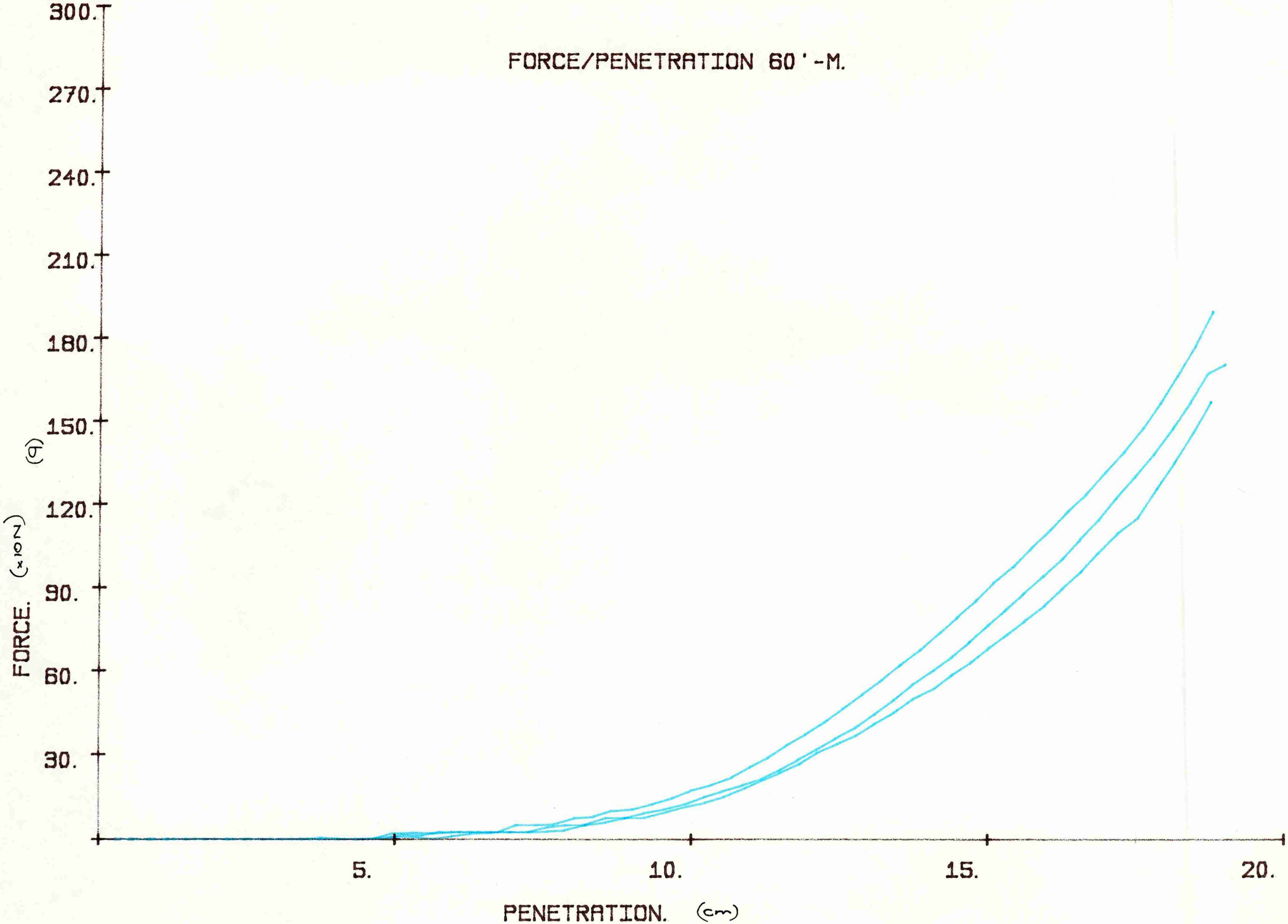

FORCE/PENETRATION 30'-N.
FORCE. (x10N)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.
PENETRATION. (cm)


FORCE/PENETRATION 30'-M.
FORCE. (x10N)
(a)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.
PENETRATION. (cm)

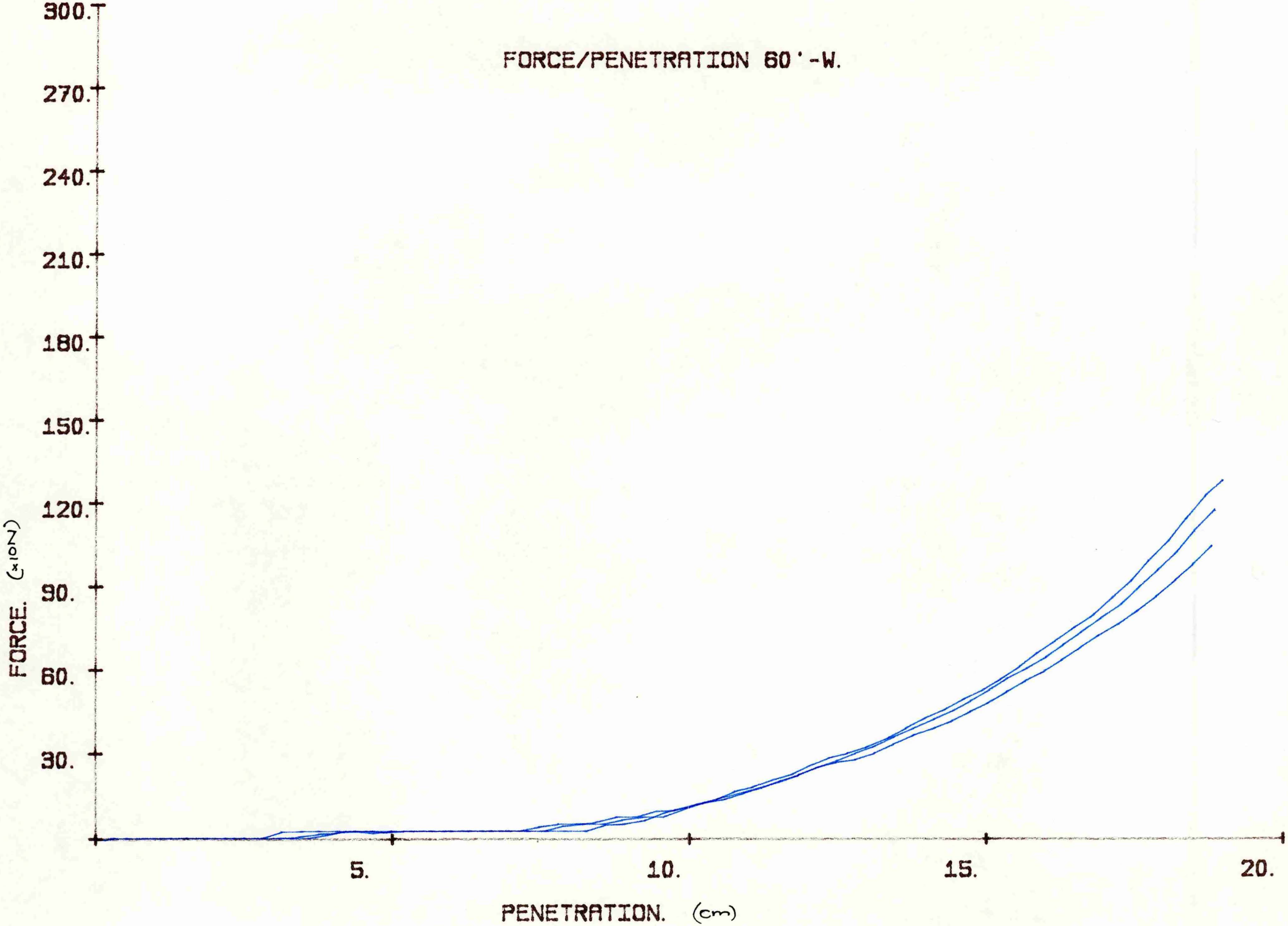


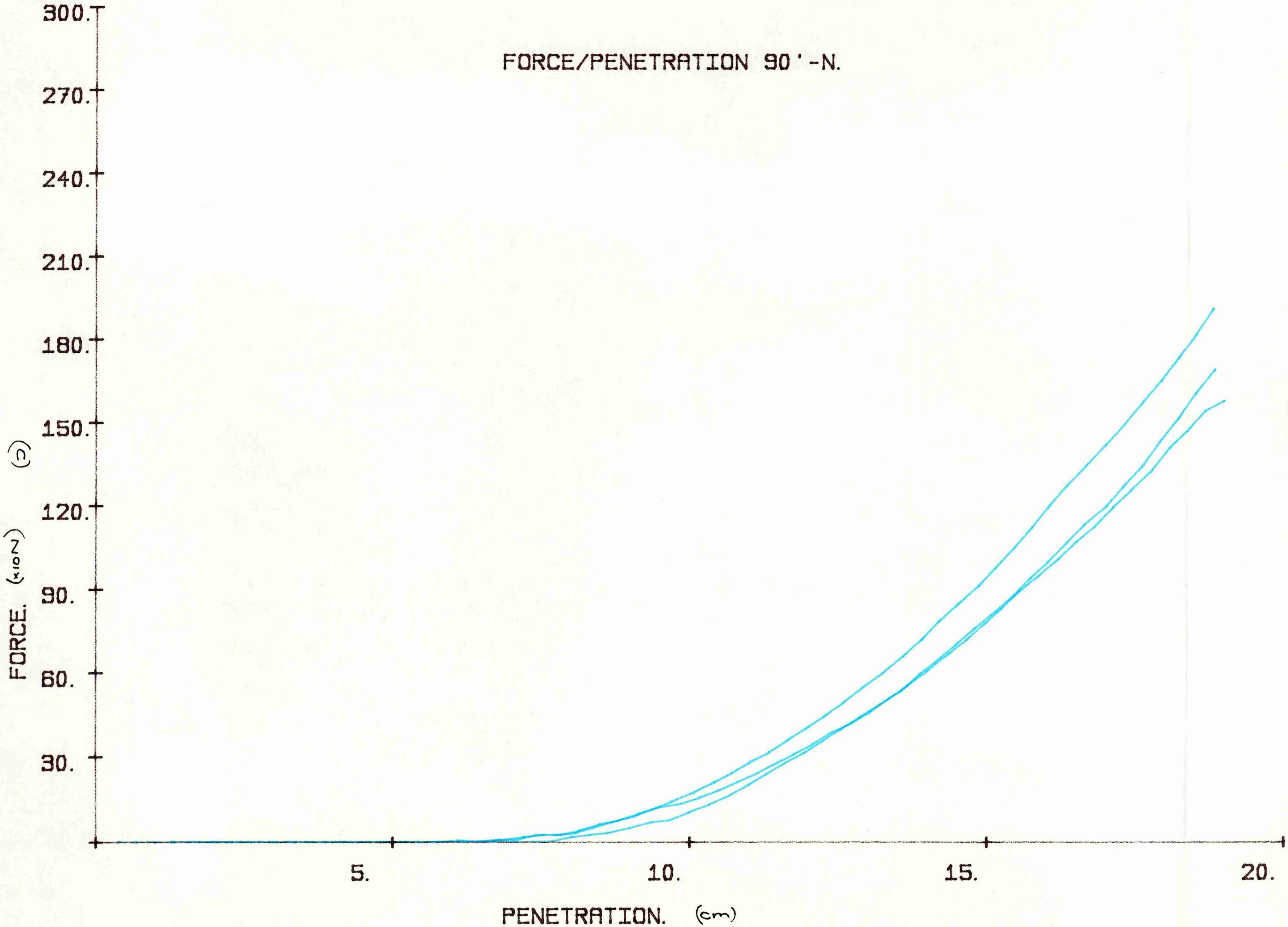
FORCE/PENETRATION 30'-W.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10 N)
5.
10.
15.
20.
PENETRATION. (cm)

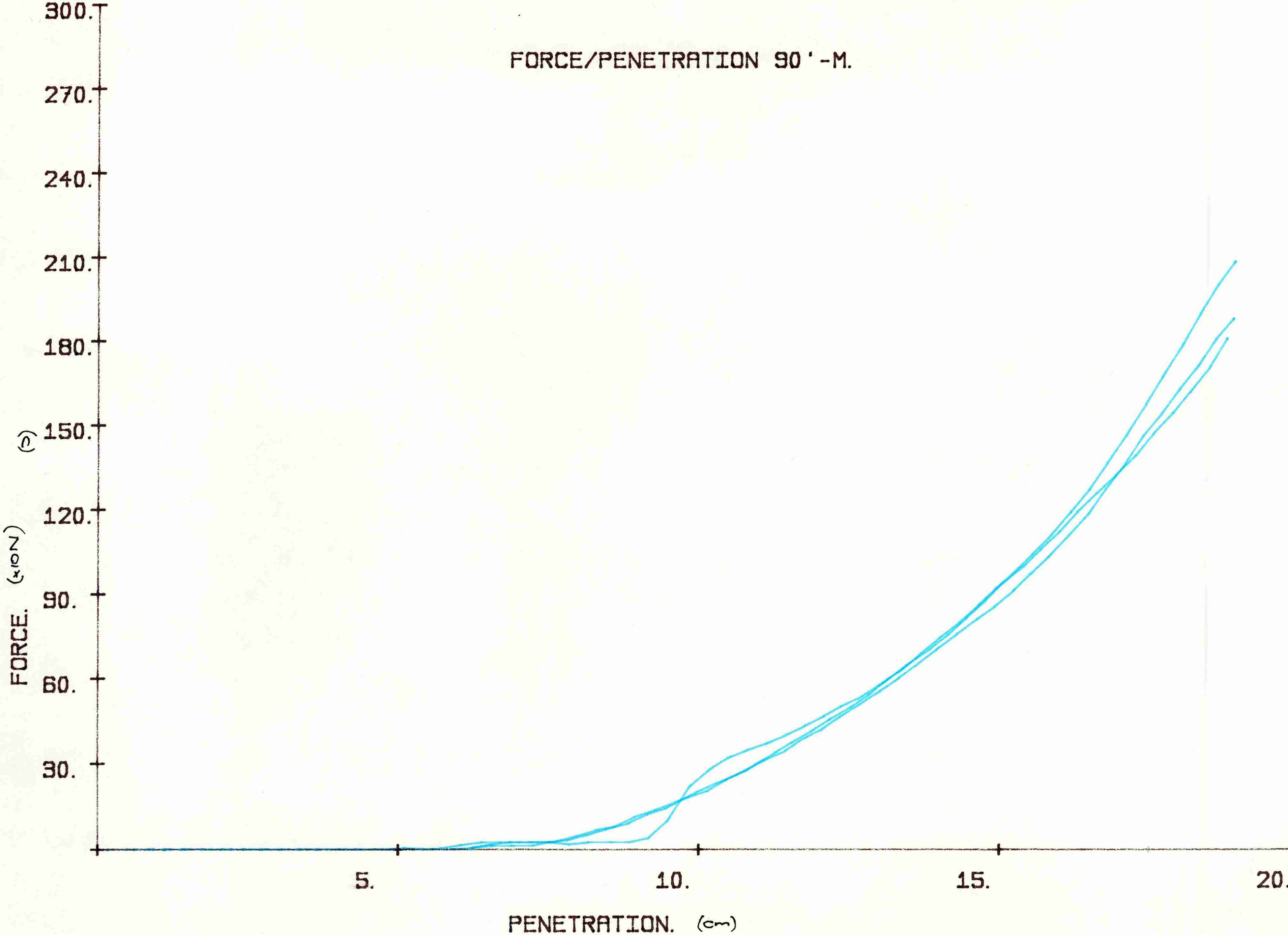

FORCE/PENETRATION 60'-N.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10N)
(b)
5.
10.
15.
20.
PENETRATION. (cm)

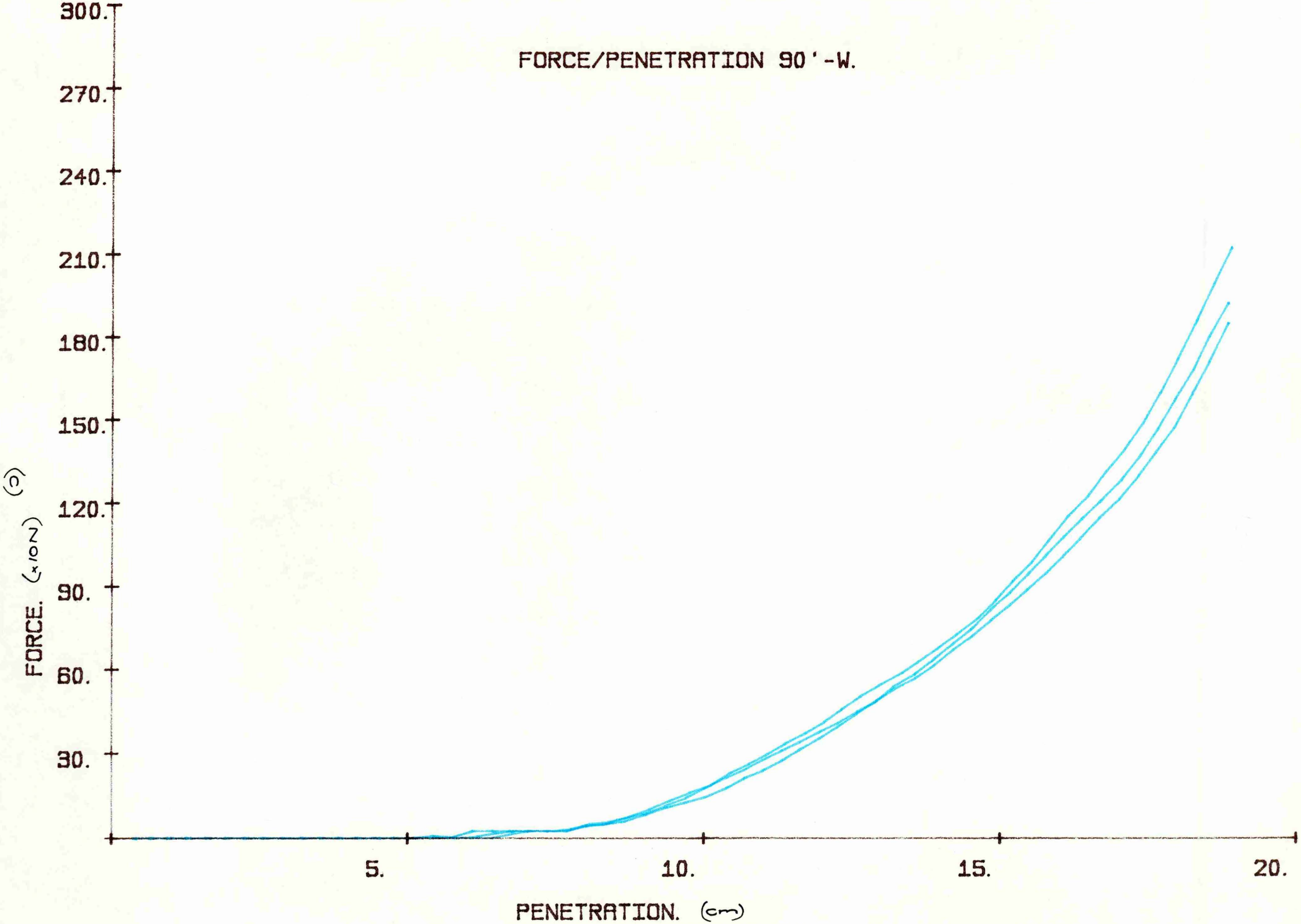


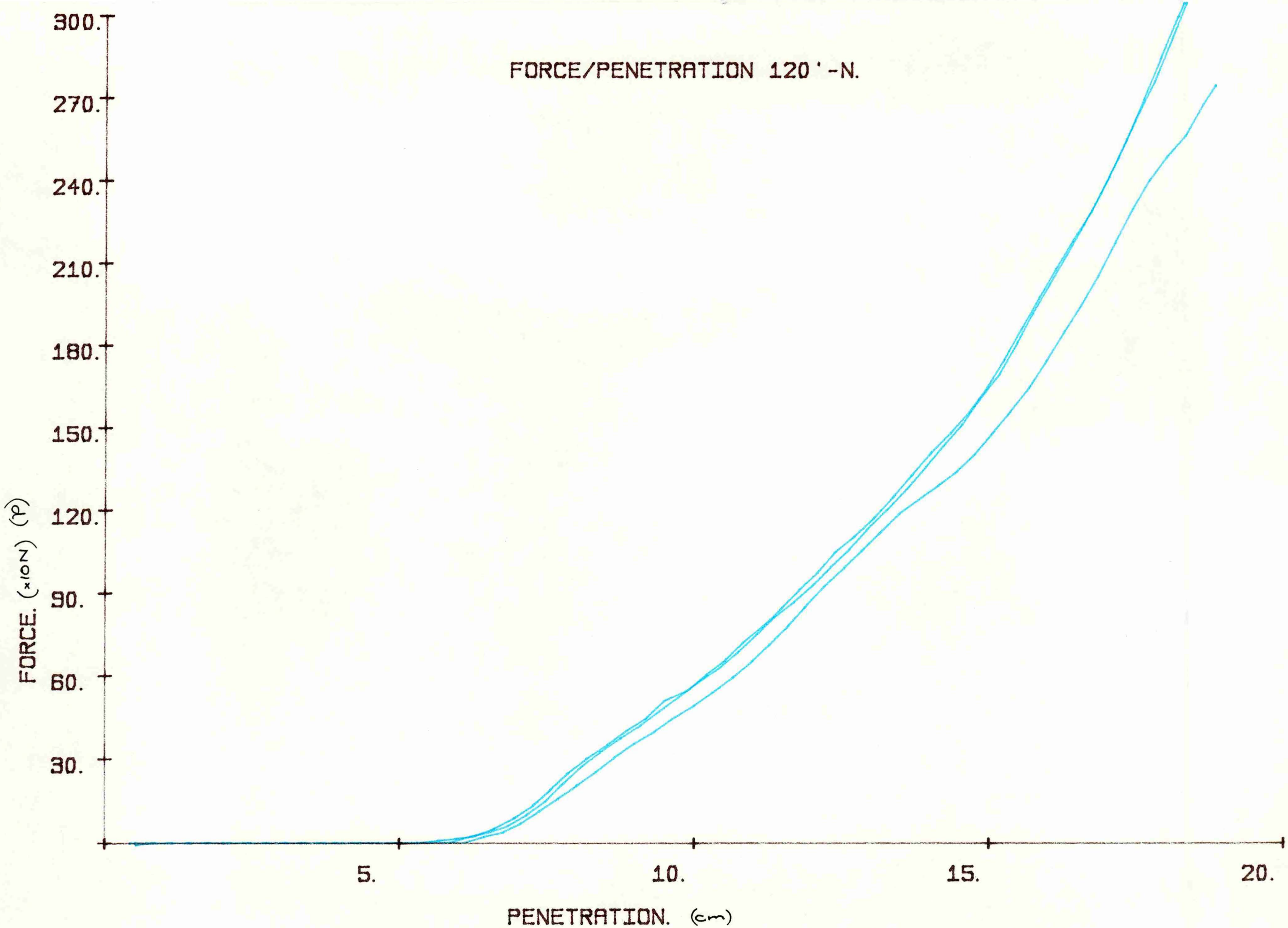
FORCE/PENETRATION 60'-M.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (×10N) (g)
5.
10.
15.
20.
PENETRATION. (cm)

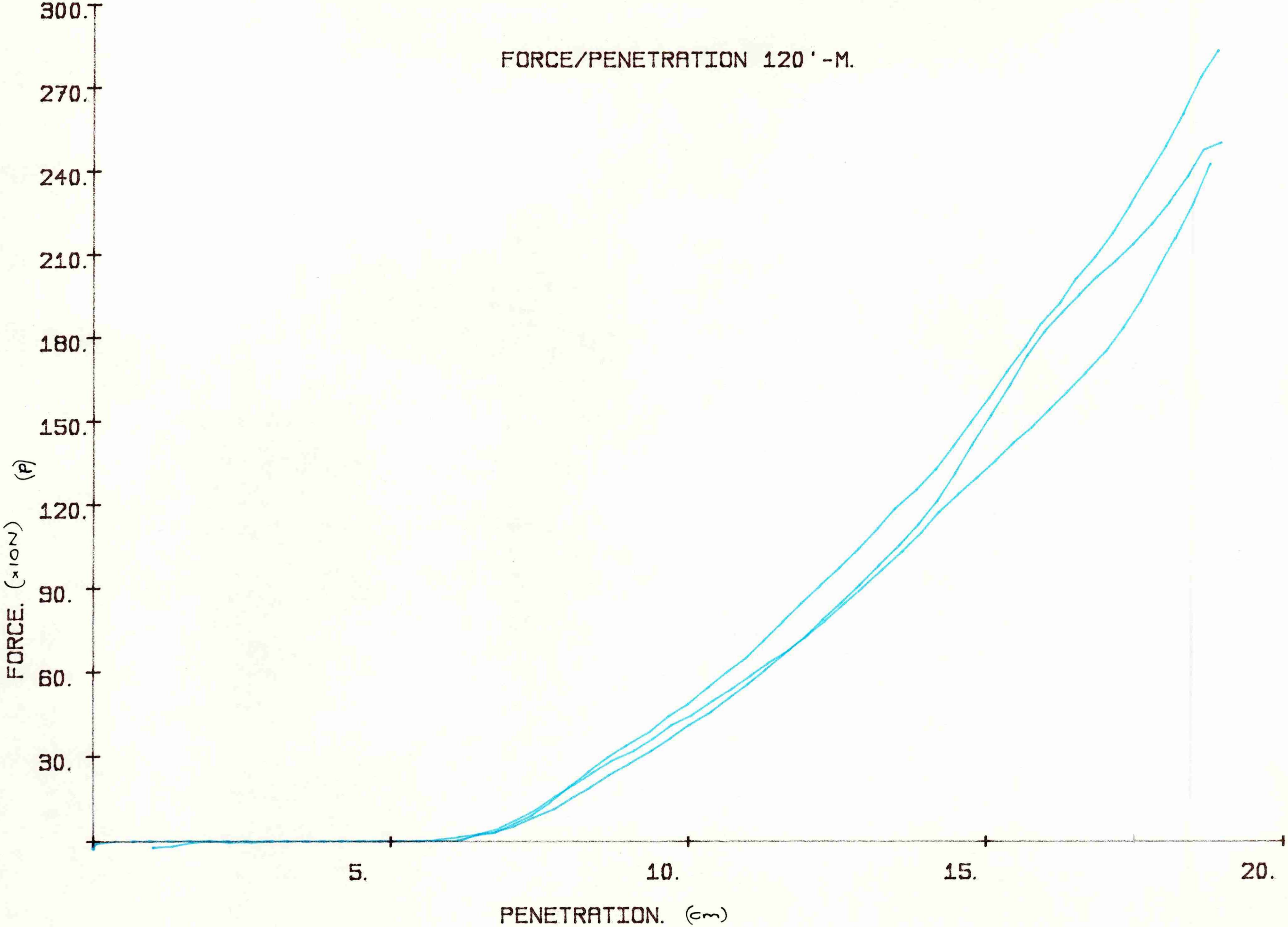

FORCE/PENETRATION 60'-W.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10N)
(9)
5.
10.
15.
20.
PENETRATION. (cm)

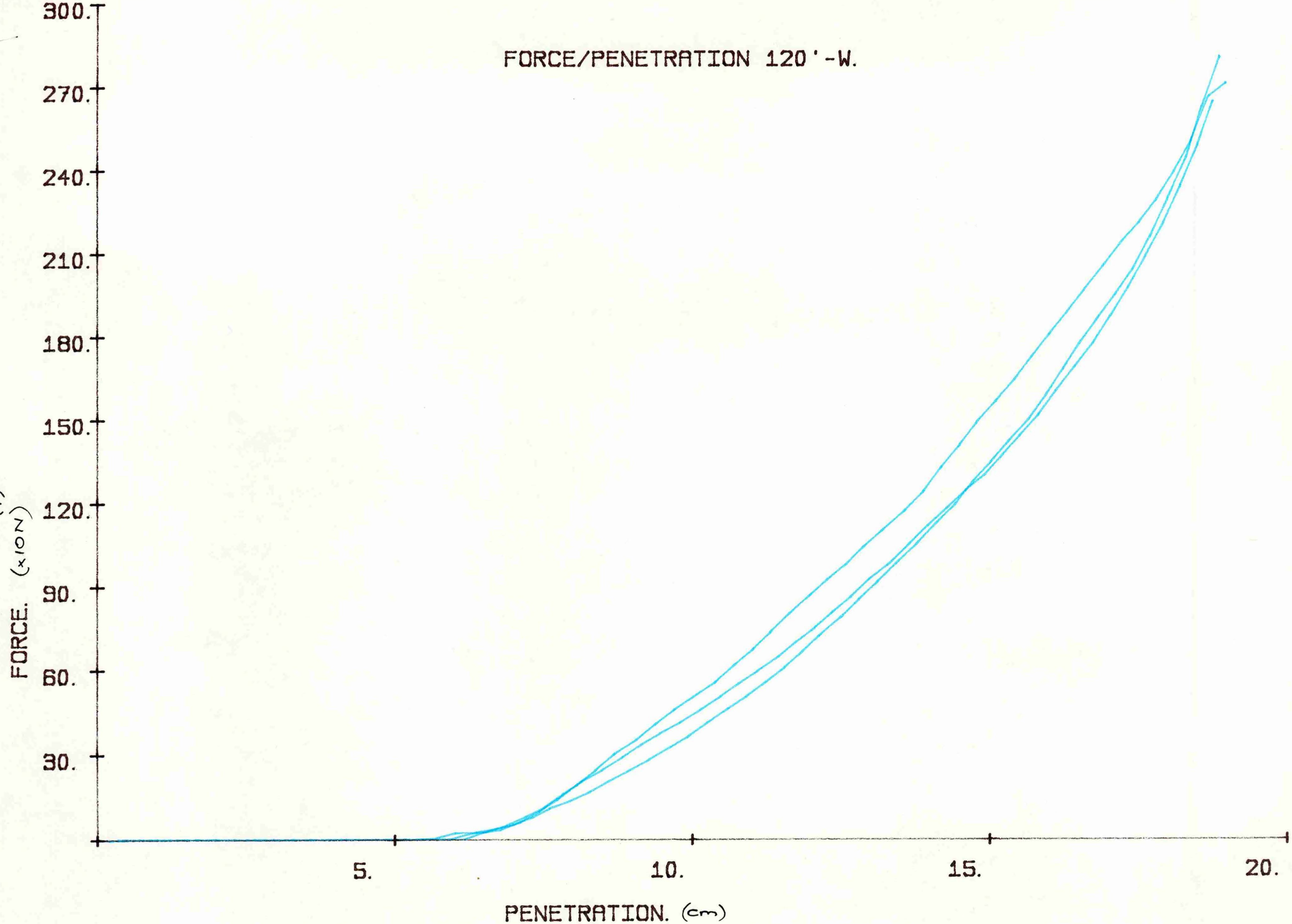

FORCE/PENETRATION 90'-N.
FORCE. (x10N)
(n)
PENETRATION. (cm)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.

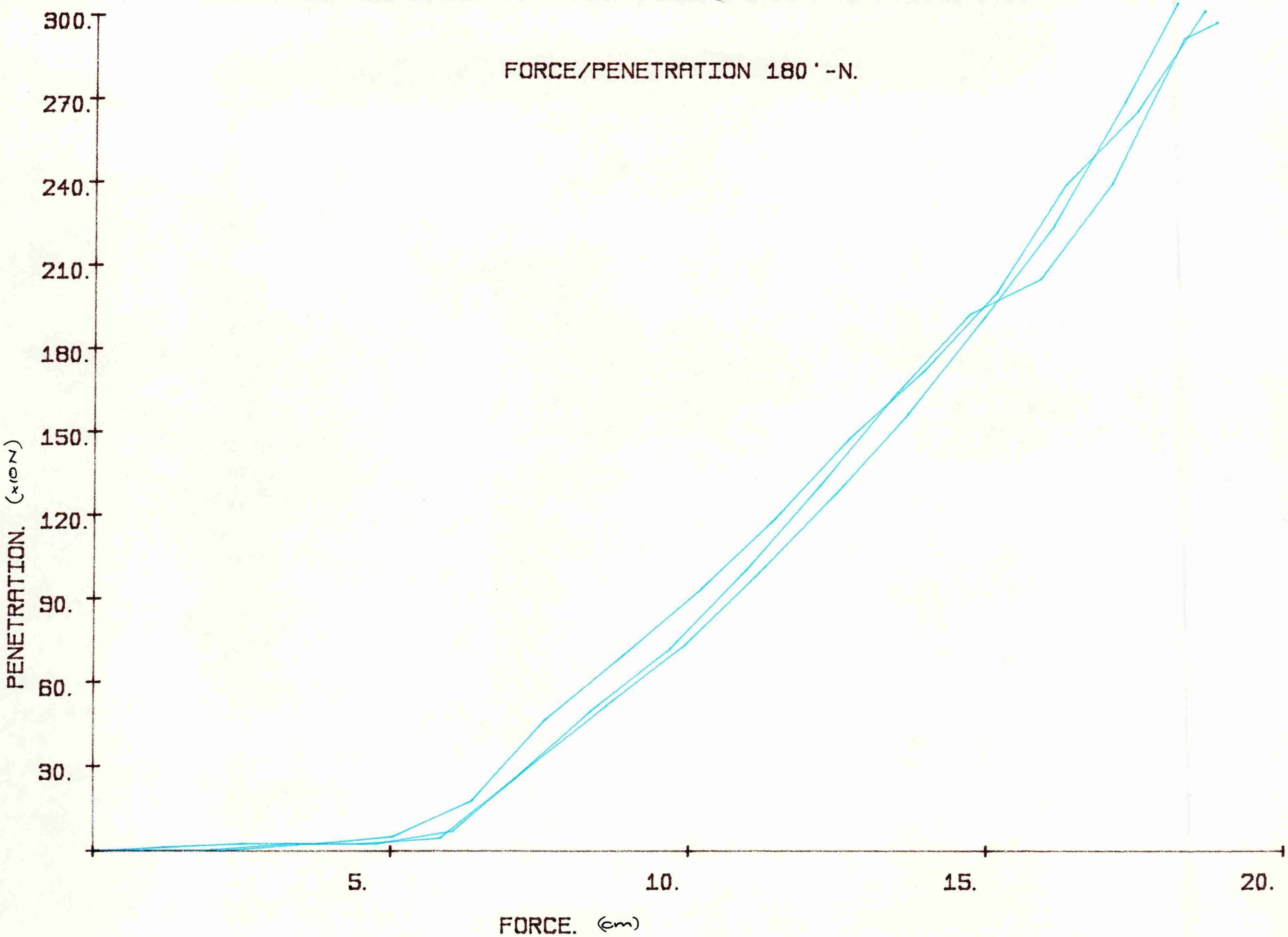

FORCE/PENETRATION 90'-M.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10N)
5.
10.
15.
20.
PENETRATION. (cm)

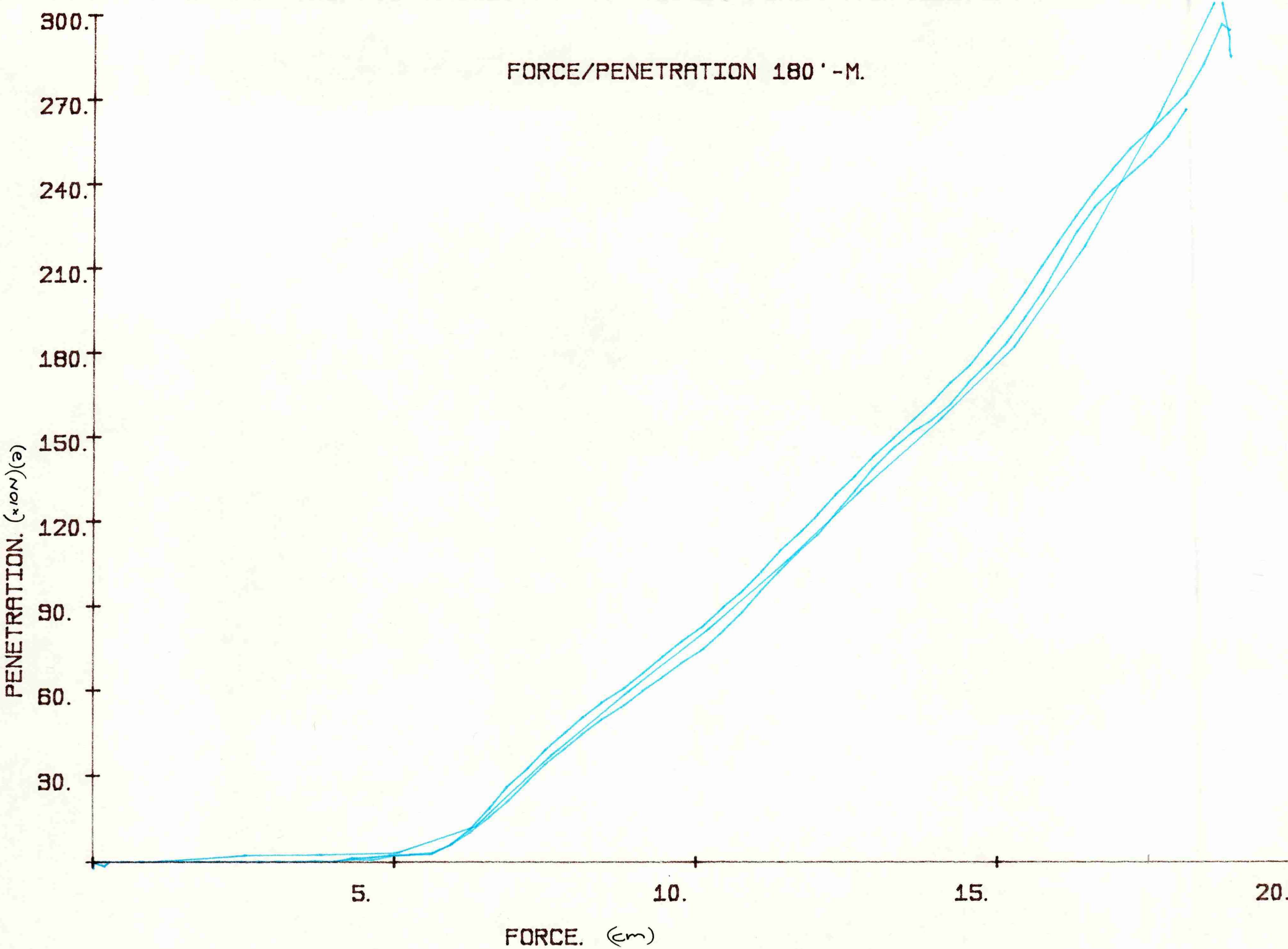

FORCE/PENETRATION 90'-W.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10N)
5.
10.
15.
20.
PENETRATION. (cm)

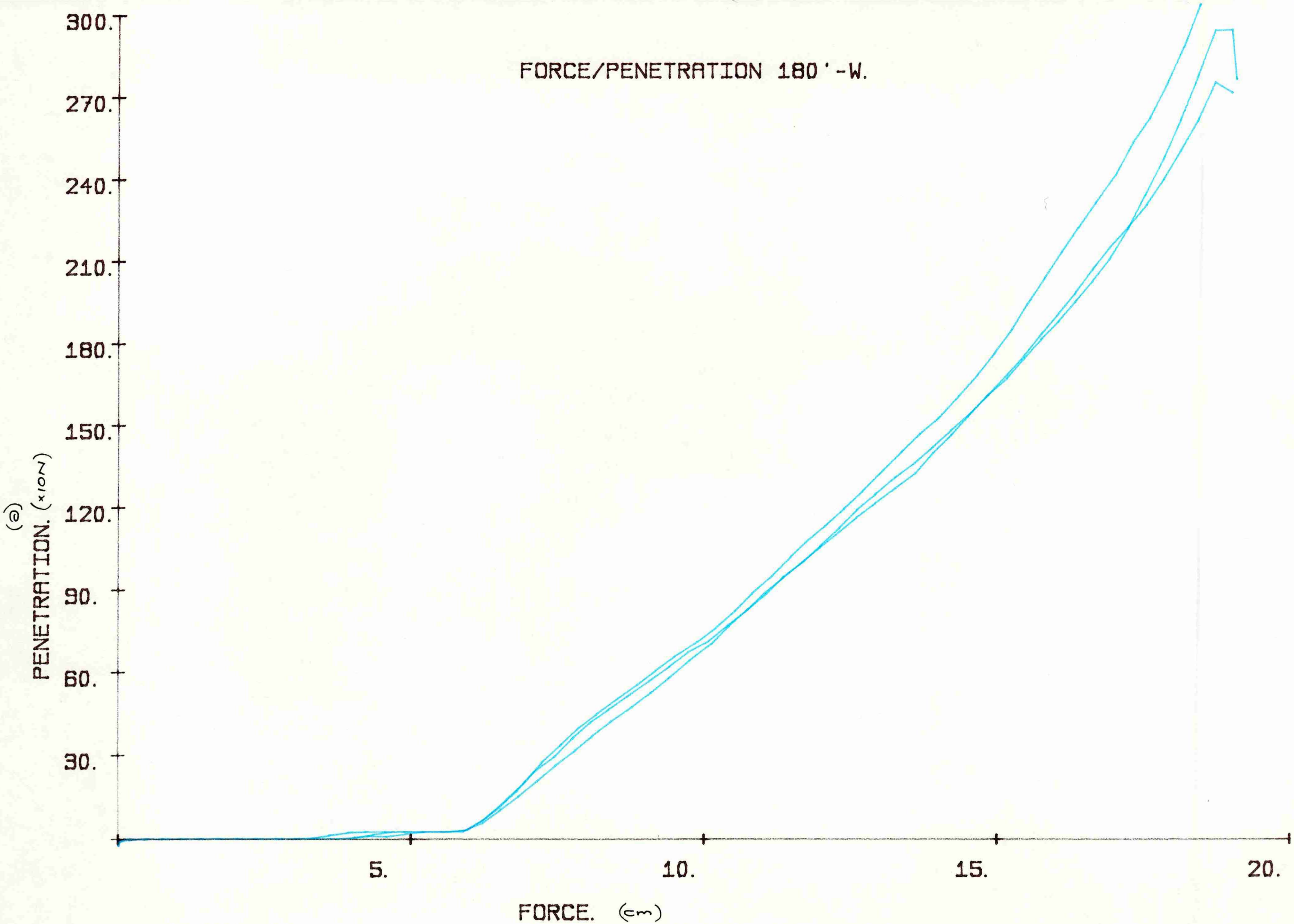

FORCE/PENETRATION 120'-N.
FORCE. (×10N) (P)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.
PENETRATION. (cm)

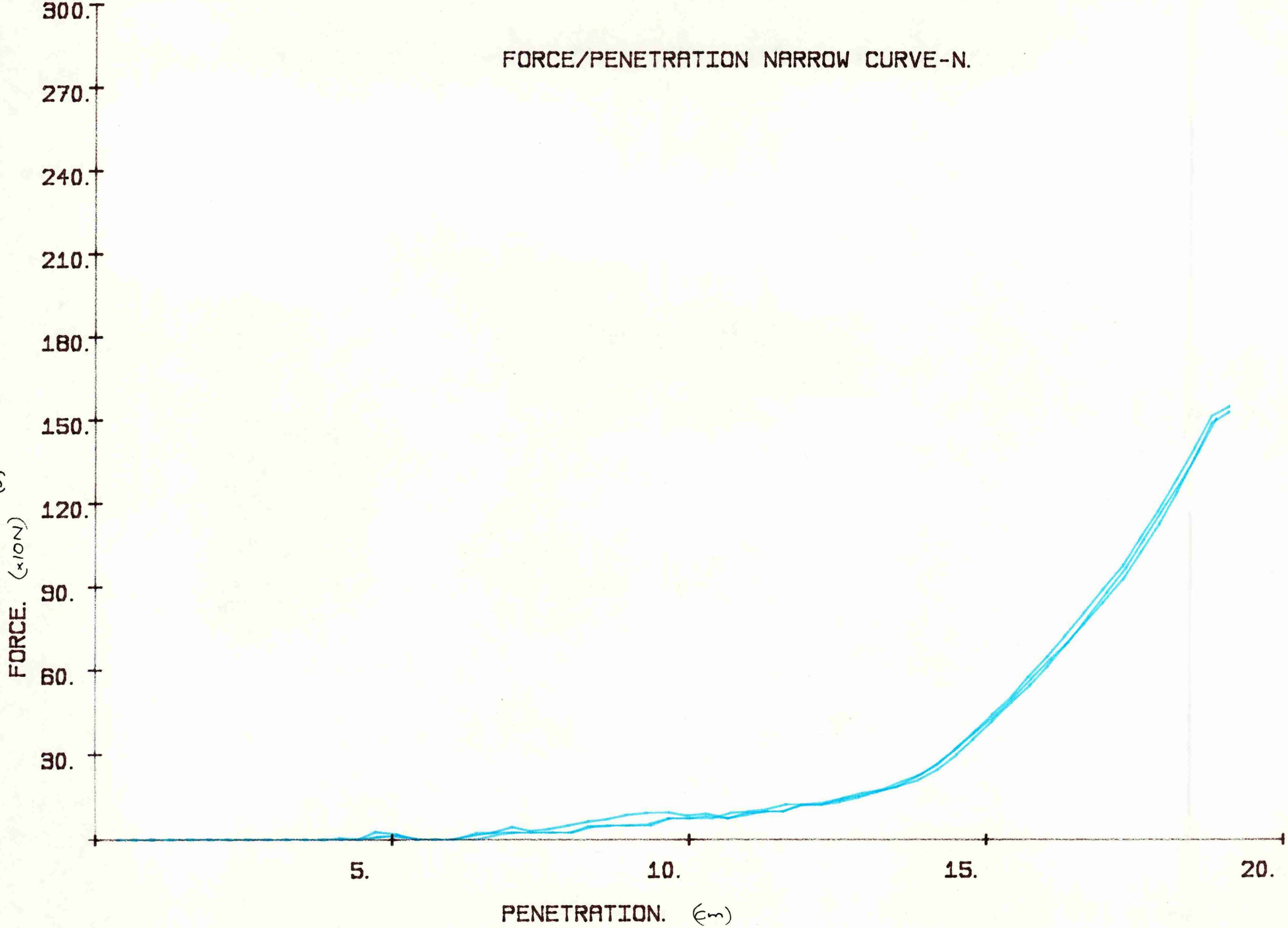

FORCE/PENETRATION 120'-M.
FORCE. (x10N) (P)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.
PENETRATION. (cm)


FORCE/PENETRATION 120'-W.
FORCE. (×10N) (P)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.
PENETRATION. (cm)

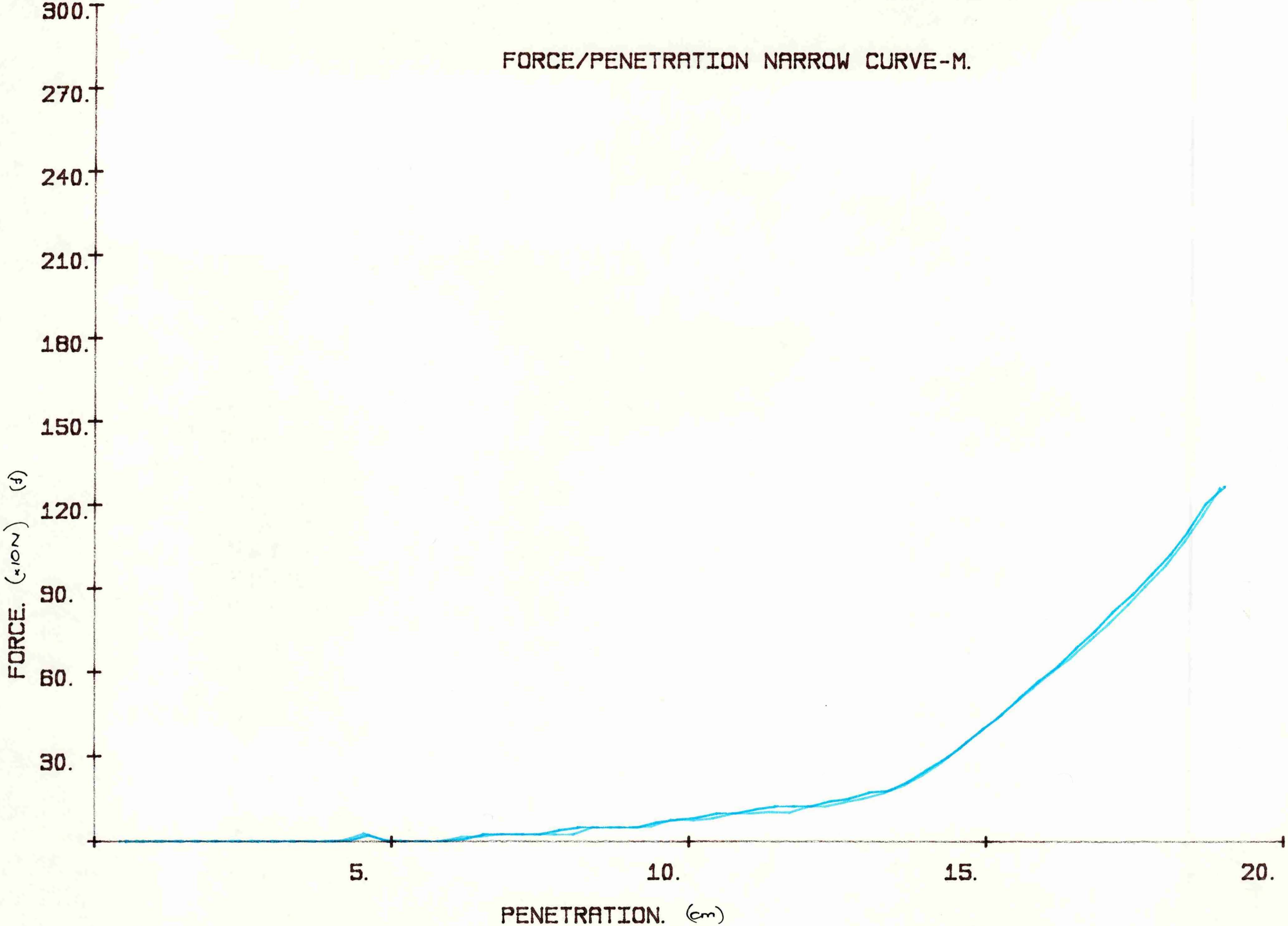

FORCE/PENETRATION 180'-N.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
(a) PENETRATION. (x10N)
5.
10.
15.
20.
FORCE. (cm)

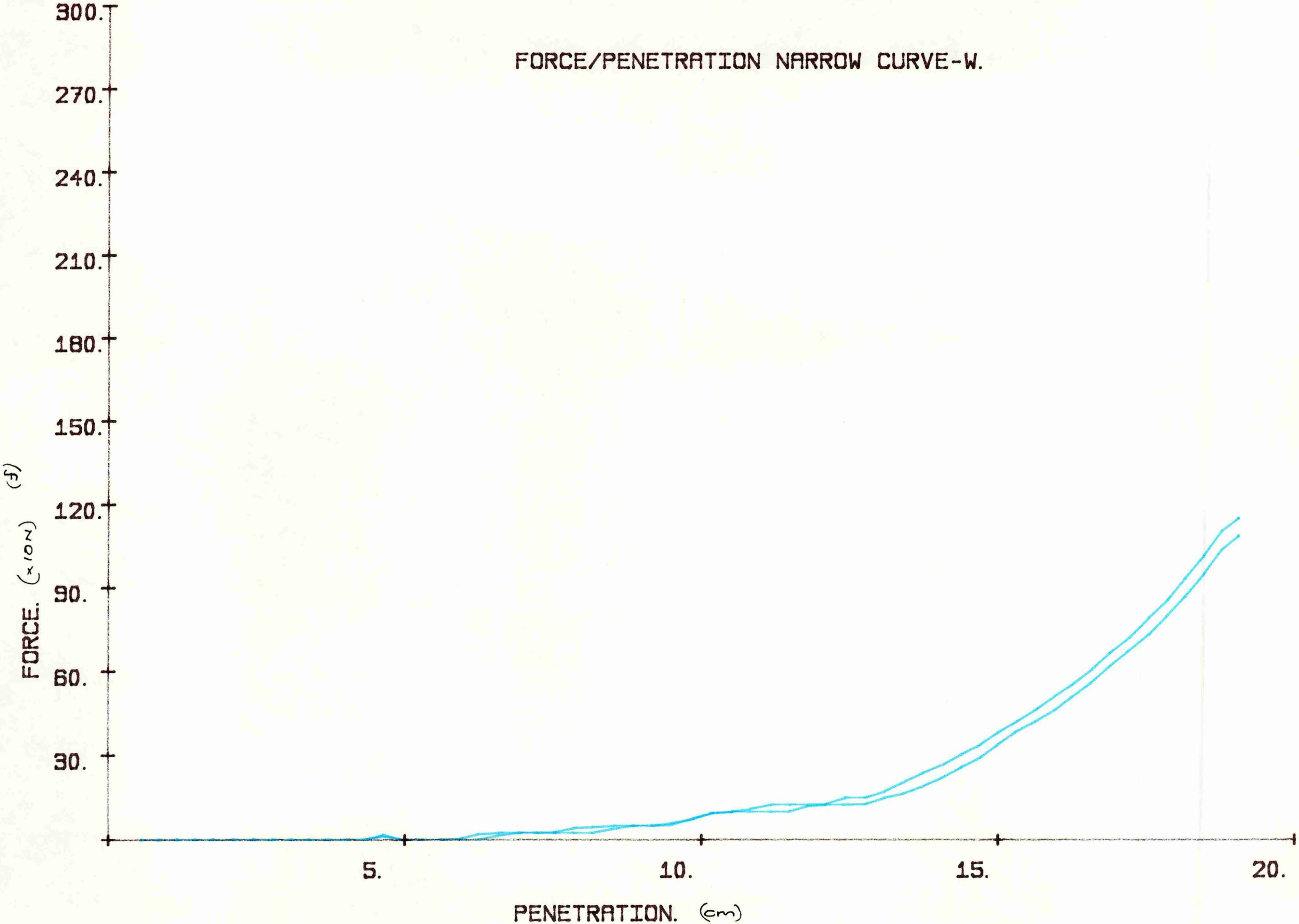

FORCE/PENETRATION 180'-M.
PENETRATION. (×10N)(a)
FORCE. (cm)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.

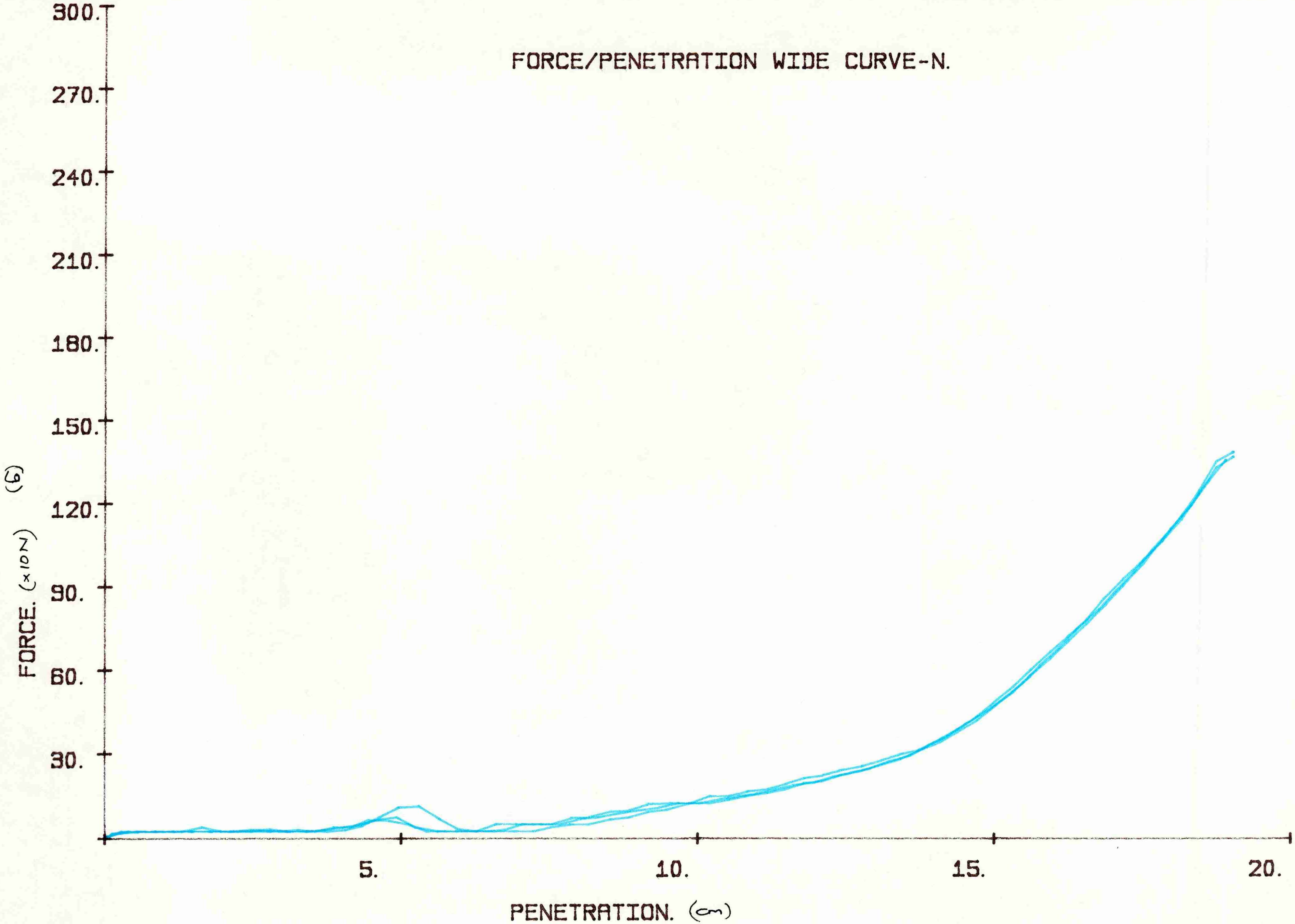

FORCE/PENETRATION 180'-W.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
(a)
PENETRATION. (x10N)
5.
10.
15.
20.
FORCE. (cm)

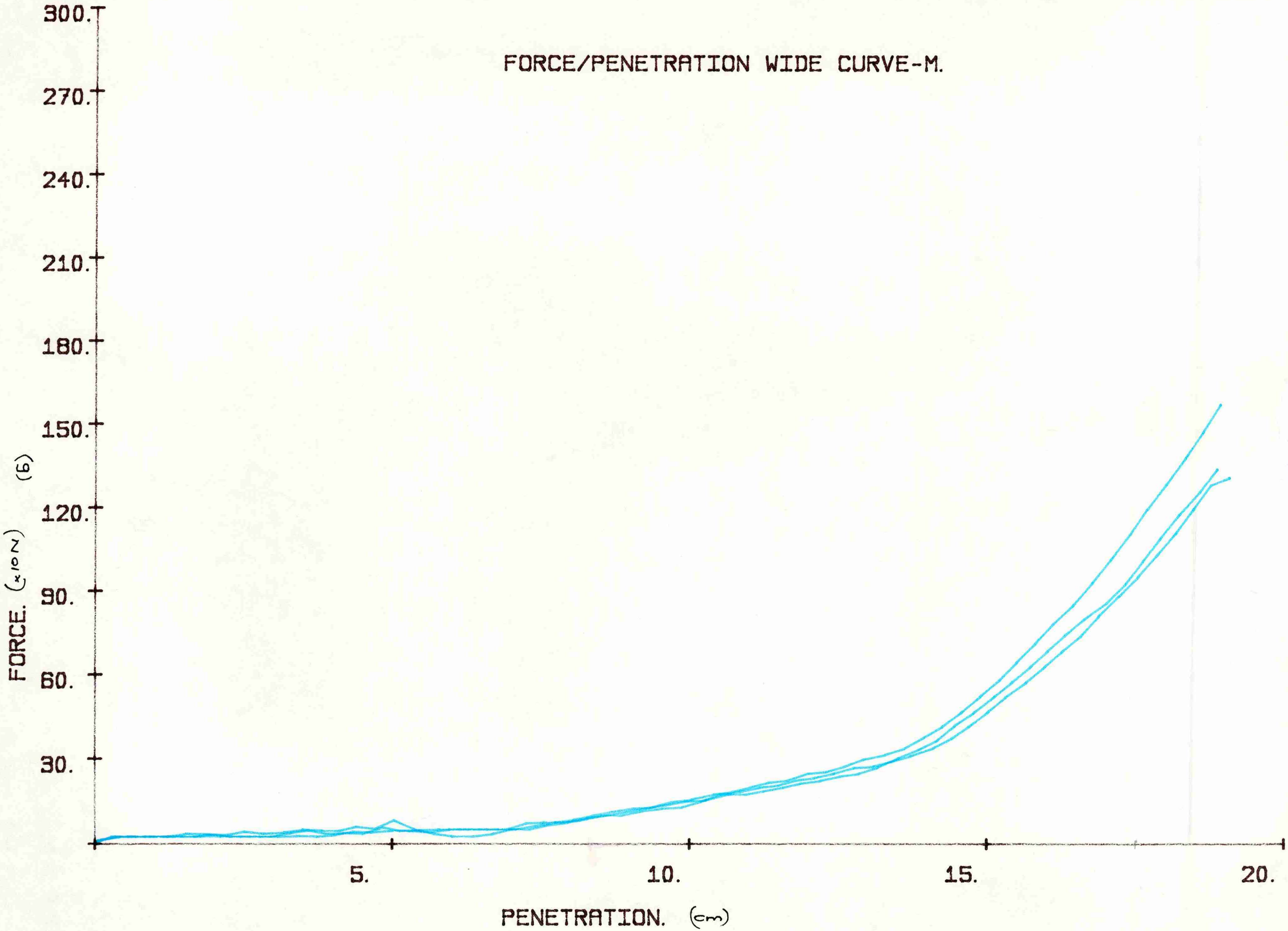


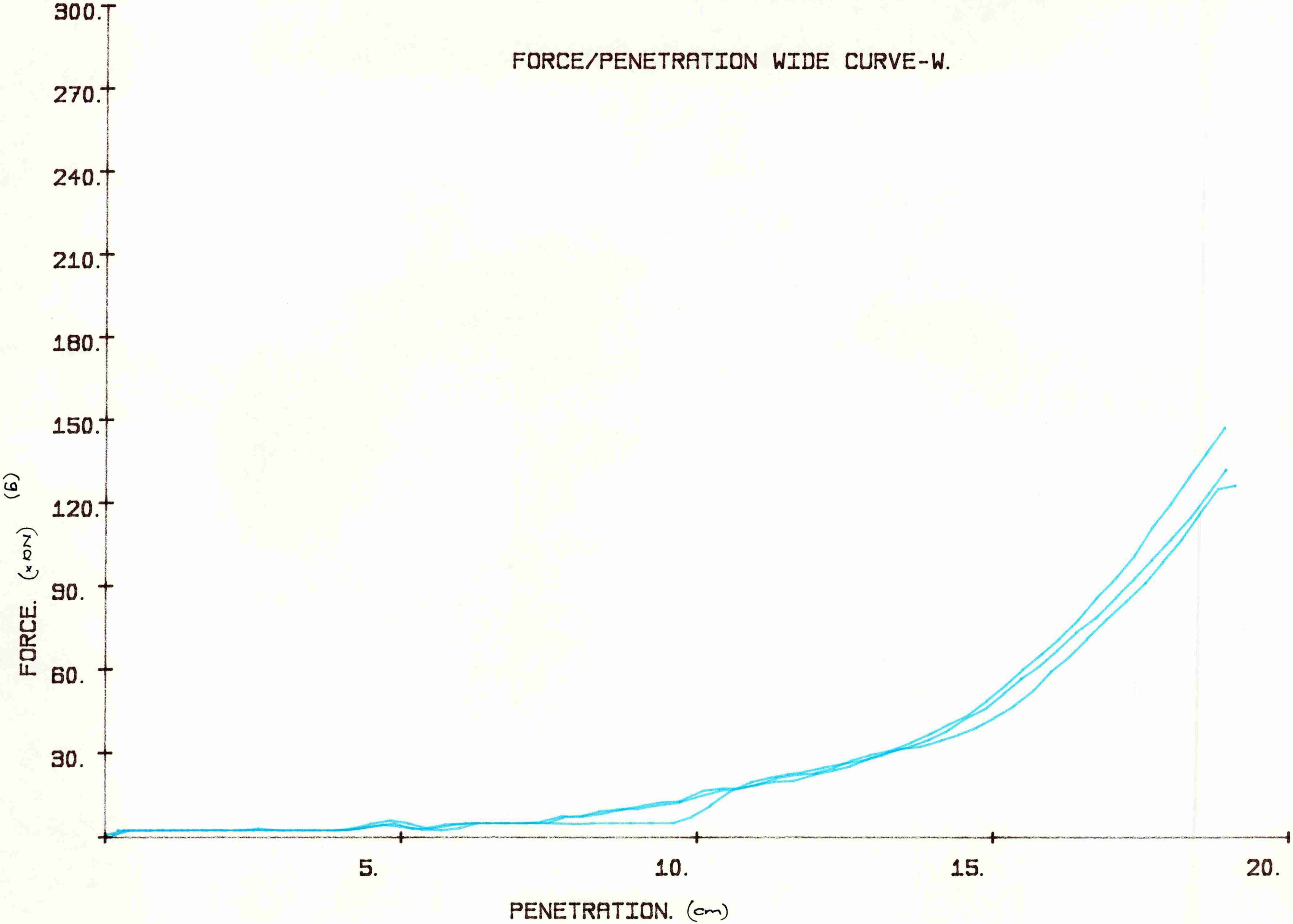
FORCE/PENETRATION NARROW CURVE-N.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (×10N)
5.
10.
15.
20.
PENETRATION. (cm)

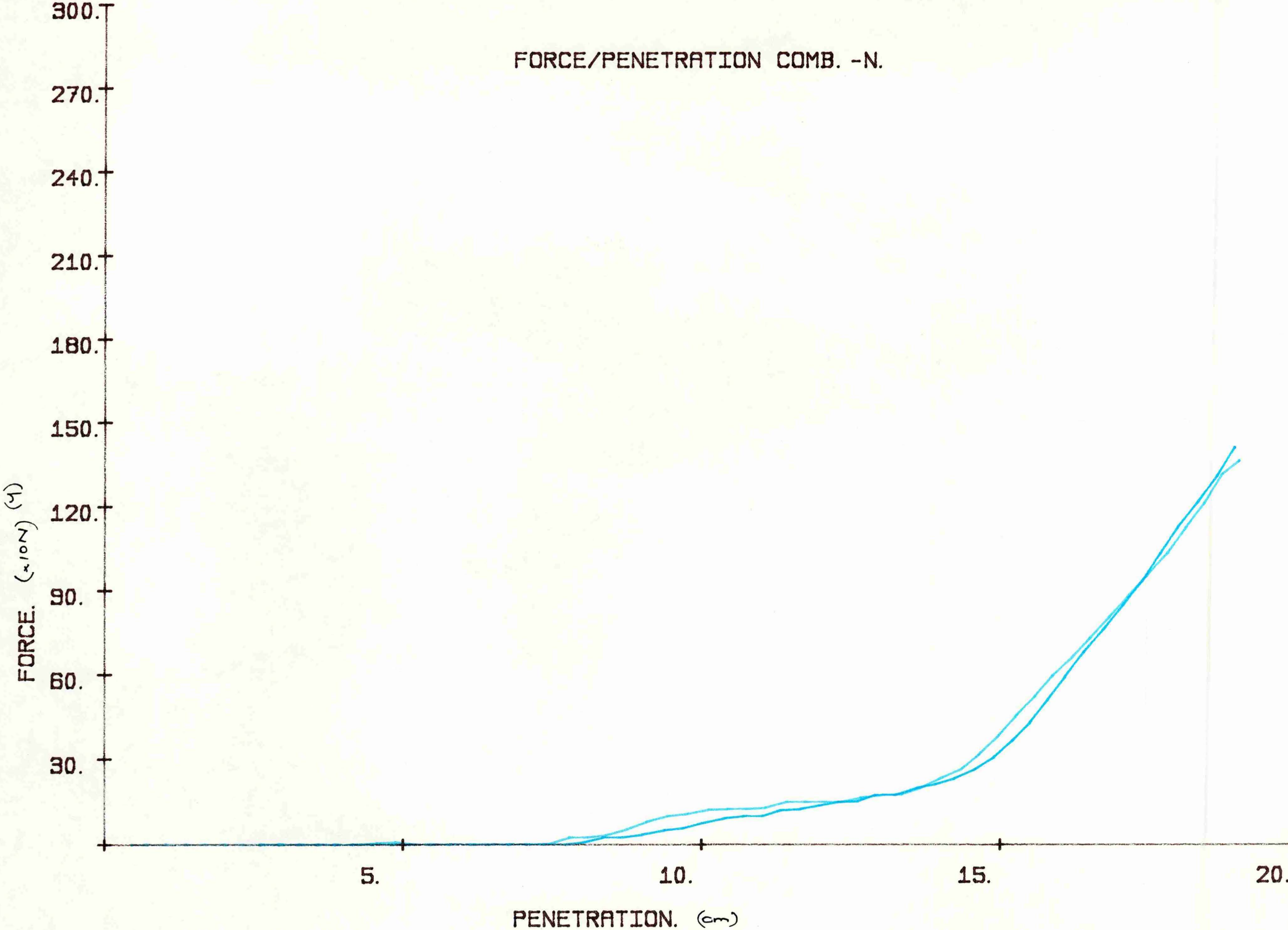

FORCE/PENETRATION NARROW CURVE-M.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10N) (f)
5.
10.
15.
20.
PENETRATION. (cm)

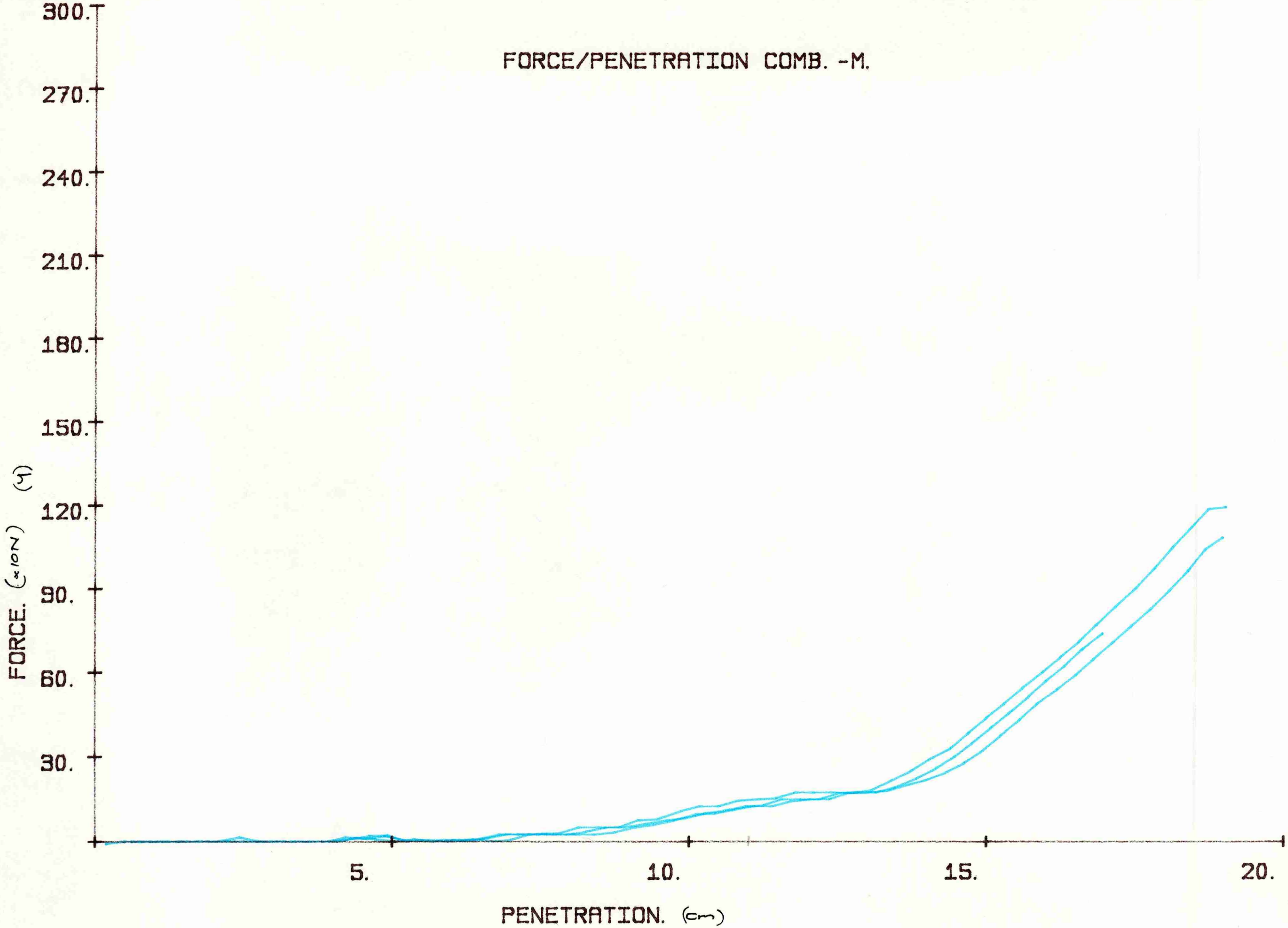

FORCE/PENETRATION NARROW CURVE-W.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10N) (f)
5.
10.
15.
20.
PENETRATION. (cm)

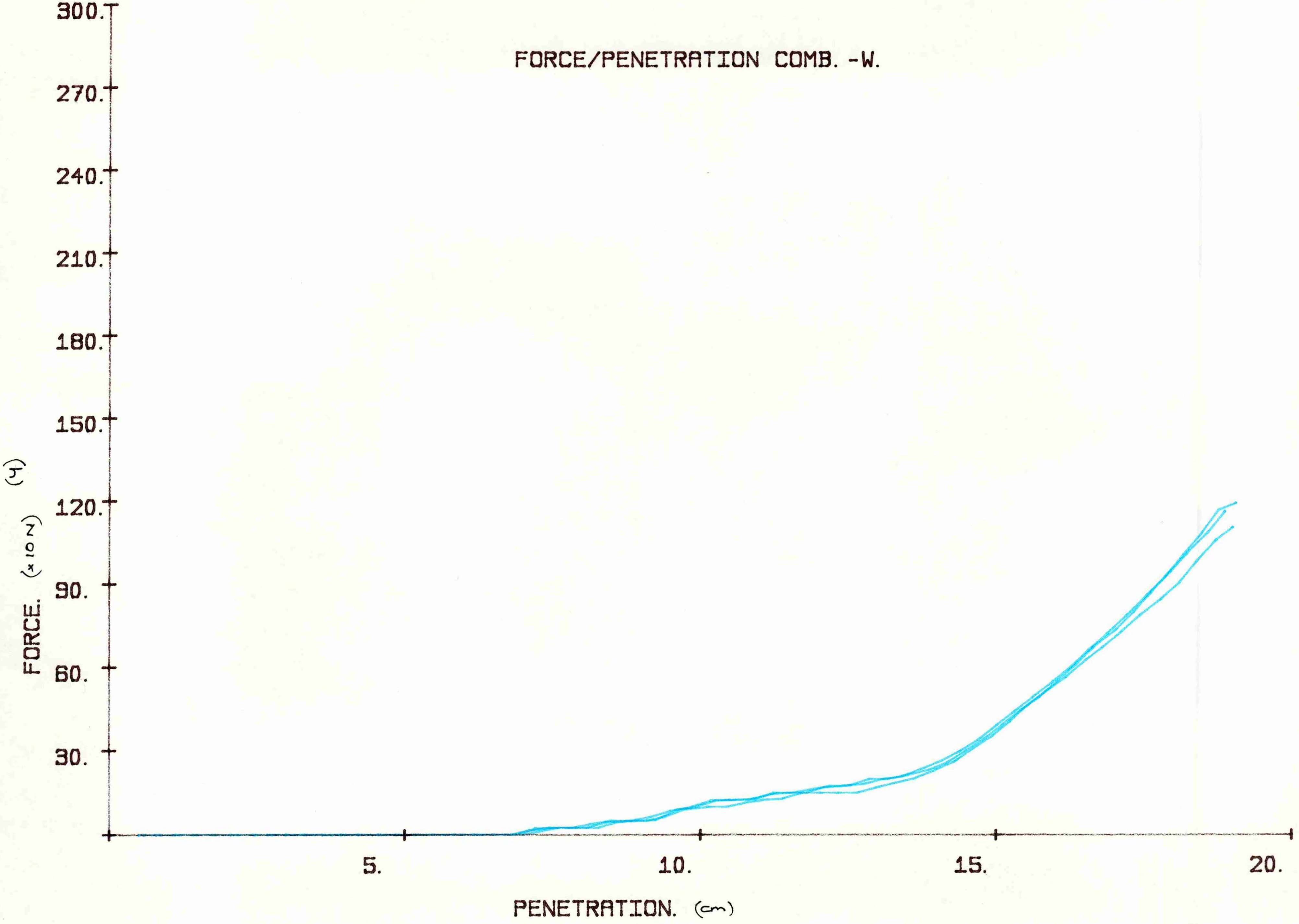

FORCE/PENETRATION WIDE CURVE-N.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10N)
(6)
5.
10.
15.
20.
PENETRATION. (cm)


FORCE/PENETRATION WIDE CURVE-M.
FORCE. (x10N)
(6)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.
PENETRATION. (cm)


FORCE/PENETRATION WIDE CURVE-W.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x10N)
(6)
5.
10.
15.
20.
PENETRATION. (cm)


FORCE/PENETRATION COMB. -N.
FORCE. (x10N) (4)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.
PENETRATION. (cm)


FORCE/PENETRATION COMB. -M.
FORCE. (×10N) (4)
PENETRATION. (cm)
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
5.
10.
15.
20.


FORCE/PENETRATION COMB. -W.
300.
270.
240.
210.
180.
150.
120.
90.
60.
30.
FORCE. (x 10 N)
(4)
5.
10.
15.
20.
PENETRATION. (cm)

APPENDIX IV

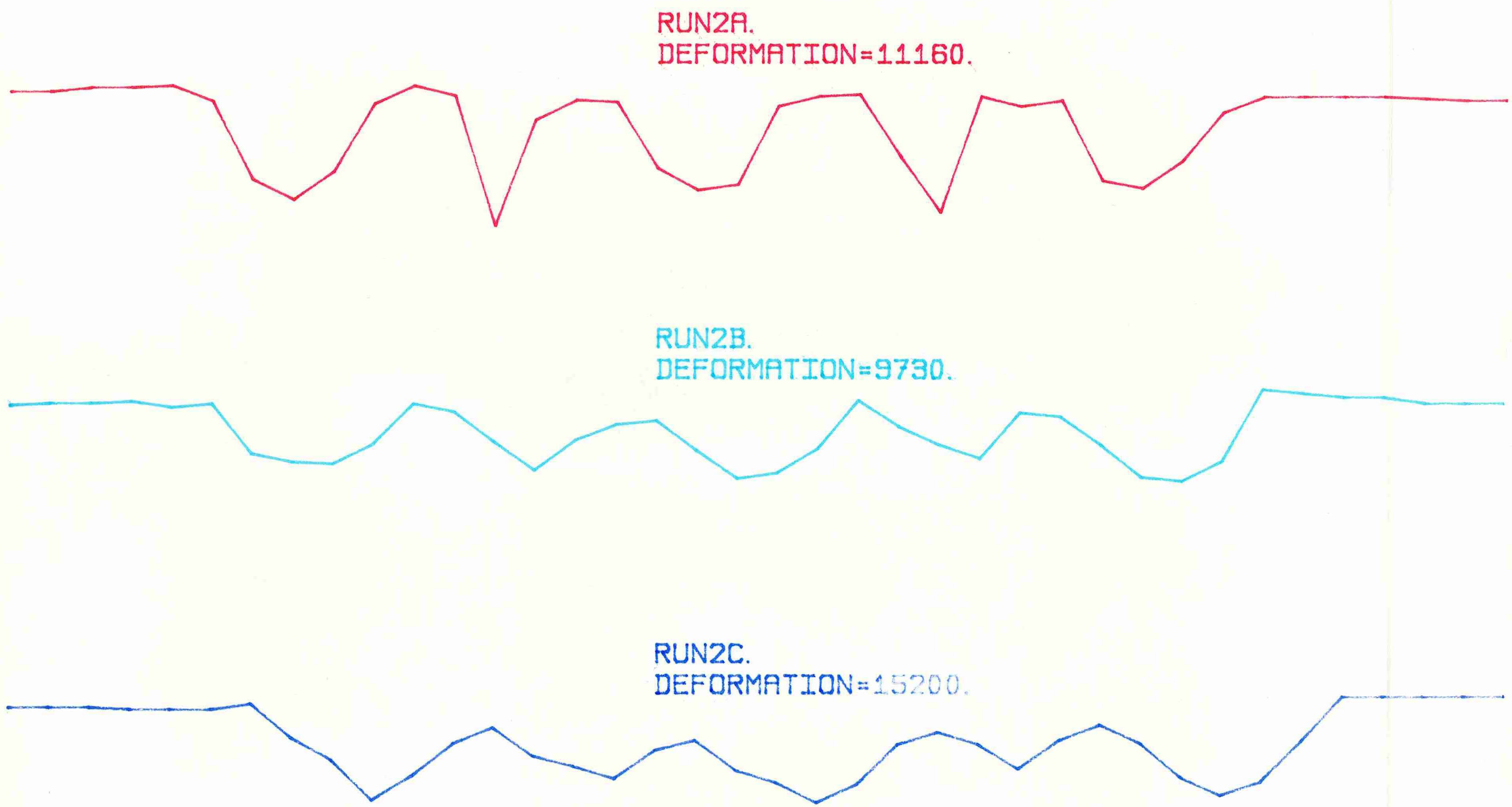
SOIL PROFILES FROM SOIL BIN

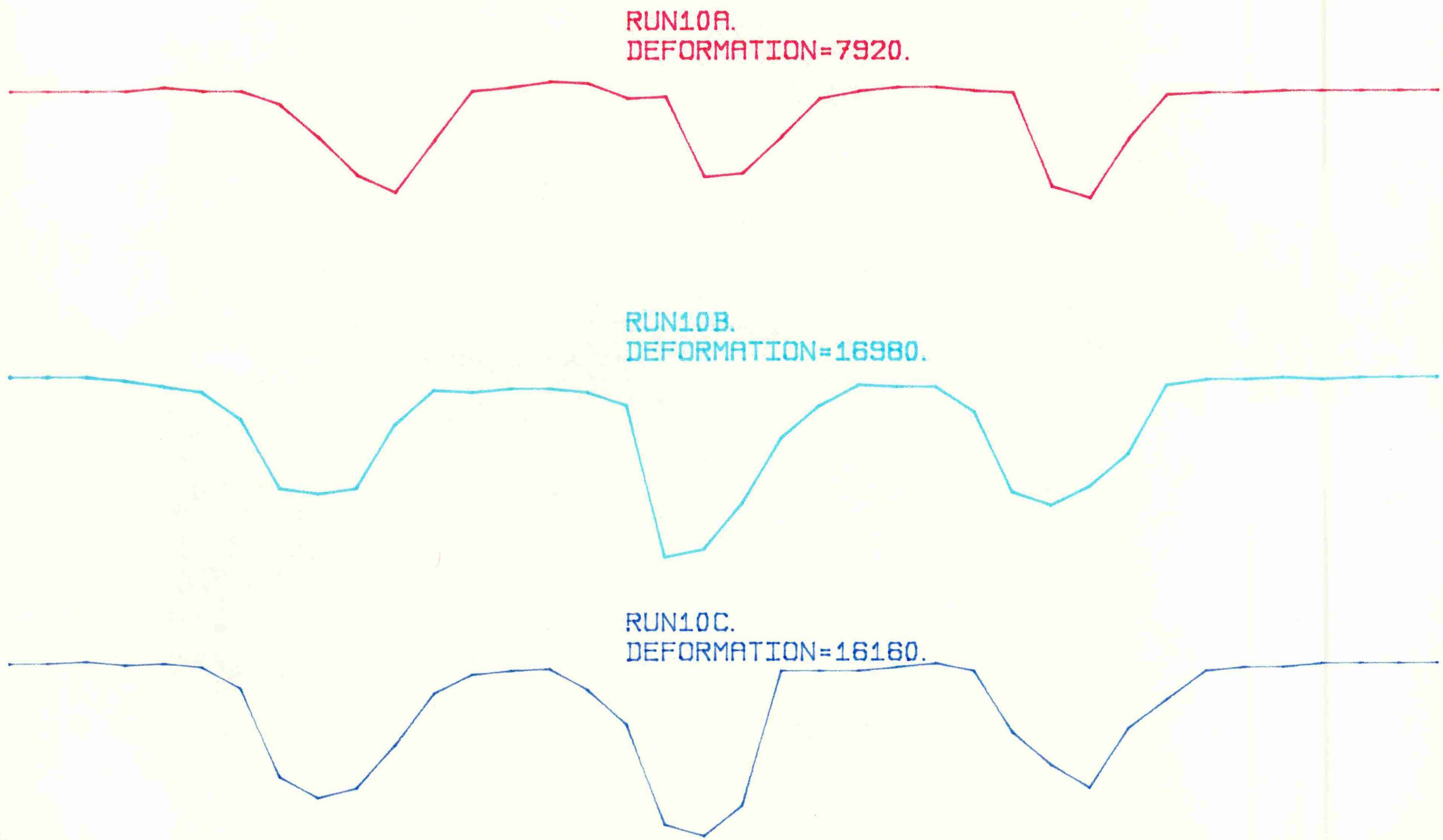
a) Three narrow / two medium 600mm, 205mm spacing

b) Conventional

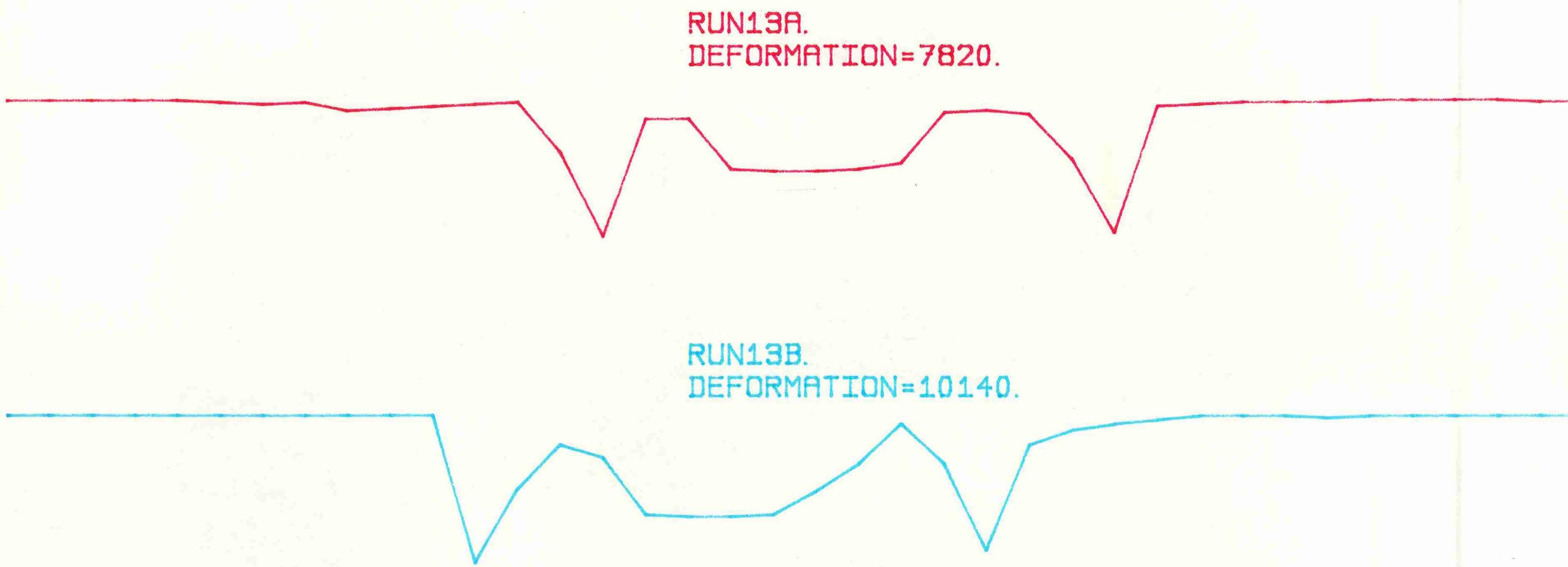
c) 600mm flat roller combination, 100mm wide, 220mm spacing

(b)


RUN2A.
DEFORMATION=11160.
RUN2B.
DEFORMATION=9730.
RUN2C.
DEFORMATION=15200.


RUN10A.
DEFORMATION=7920.
RUN10B.
DEFORMATION=16980.
RUN10C.
DEFORMATION=16160.

(b)



(c)

APPENDIX V

SOIL BIN PENETROMETER PROFILES

UNITS ARE kN/m2

a)	205mm spacing	650mm	smaller dia	
b)	" "	600mm	"	"
c)	" "	550mm	"	"
d)	290mm "	550mm	"	"
e)	" "	600mm	"	"
f)	" "	650mm	"	"
g)	180mm "	650mm	"	"
h)	" "	600mm	"	"
i)	" "	550mm	"	"
j)	Conventional narrow press, 180mm spacing			
k)	Flat Combination 100mm wide			
l)	" "	150mm "		

(a)

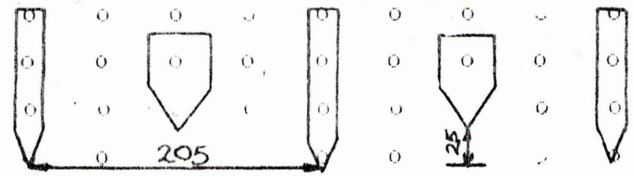
DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0		0	0	0		0	0	0		0	0	0	0	0
3	0	0	0	0	0		0	0	0		0	0	0		0	0	0	0	0
4	0	0	0	0	0		0	0	0		0	0	0		0	0	0	0	0
5	0	0	0	0	30		0	205mm	90		30	25	30		30	0	0	0	16.7
6	0	0	0	0	120	0	30	0	360	0	300	0	150	0	150	0	0	0	93.3
7	0	0	0	0	330	60	300	120	660	90	540	0	390	0	360	0	0	0	240
8	0	0	0	0	540	450	570	510	840	480	840	390	660	210	540	0	0	0	550
9	30	30	60	60	690	780	780	690	990	810	930	630	840	480	660	60	0	0	770
10	180	180	180	150	720	840	930	810	1080	930	1080	840	930	630	750	210	150	150	897.
11	240	240	270	240	780	930	990	930	1170	1050	1140	960	1050	780	780	270	270	240	1000
12	300	330	330	360	840	930	1050	990	1290	1110	1260	1020	1110	840	840	390	330	300	1067
13	390	450	450	420	960	990	1110	1110	1410	1140	1290	1080	1170	930	900	450	390	420	1137
14	480	540	570	510	1080	1050	1230	1200	1590	1260	1290	1110	1320	1050	1020	570	510	540	1233
15	600	630	630	600	1410	1170	1410	1380	1590	1410	1290	1200	1530	1110	1230	630	600	630	1343

	6	7	8	9	10	11	12	13	14	AVE
TOP	430	550	440	830	460	770	340	630	230	520
MIDL	900	990	910	1180	1030	1160	940	1030	750	988.
BOTM	1070	1250	1230	1530	1270	1290	1130	1340	1030	1238
AV	800	930	860	1180	920	1073	803.	1000	670	915.

RUN 1 - WT1

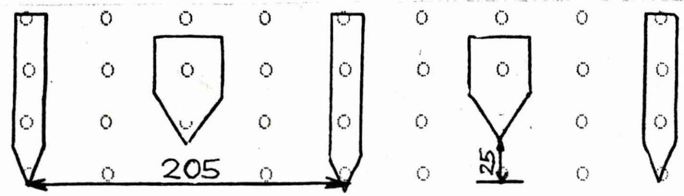
(a)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0
4	0	0	0	0			0				0				0	0	0	0	0
5	0	0	0	0	30	0	0	0	0	0	0	0	0	0	30	0	0	0	0
6	0	0	0	0	90	0	30	0	60	0	0	0	30	0	90	0	0	0	13.3
7	0	0	0	0	[redacted]	60	[redacted]	30	[redacted]	0	60	0	[redacted]	0	[redacted]	0	0	0	56.7
8	0	0	0	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	0	0	353.
9	60	30	60	60	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	30	30	30	680
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	900	870	990	990	1080	900	1020	990	840	[redacted]	[redacted]	[redacted]	[redacted]	953.
11	[redacted]	[redacted]	[redacted]	[redacted]	870	990	1110	1230	1230	1320	1230	1320	1140	1020	[redacted]	[redacted]	[redacted]	[redacted]	1177
12	[redacted]	[redacted]	[redacted]	[redacted]	1020	1020	1200	1320	[redacted]	1470	1320	1440	1290	1080	840	[redacted]	[redacted]	[redacted]	1293
13	[redacted]	[redacted]	[redacted]	[redacted]	1140	1080	1350	1380	[redacted]	1470	1440	[redacted]	1350	1110	960	[redacted]	[redacted]	[redacted]	1353
14	[redacted]	[redacted]	[redacted]	[redacted]	1320	1110	1440	1470	[redacted]	1470	1440	1470	1380	1200	990	[redacted]	[redacted]	[redacted]	1387
15	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1230	1440	1470	[redacted]	1470	1440	1470	1380	1470	1200	[redacted]	[redacted]	[redacted]	1430
TOP						410	350	440	380	340	290	360	400	300					363.
MIDL						970	1060	1180	1240	1290	1150	1260	1140	980					1141
BOTM						1140	1410	1440	1500	1470	1440	1480	1370	1260					1390
AV						840	940	1020	1040	1033	960	1033	970	847.					965.



RUN 1 · WT 2

(a)

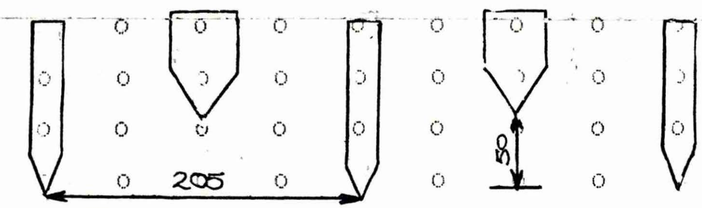


DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	60	0	0	0	0	0	0	0	0	0	30	0	0	0	0
7	0	0	0	0	120	0	0	0	30	0	0	0	30	0	120	0	0	0	6.67
8	0	0	0	0	210	60	120	30	60	60	30	90	60	60	210	0	0	0	63.3
9	60	60	60	60	390	360	270	390	240	330	240	420	240	330	360	90	60	90	313.
10	210	210	210	210	540	720	540	690	510	660	480	630	510	600	450	240	210	210	593.
11	300	300	300	270	720	930	840	930	810	960	810	930	810	840	630	330	300	300	873.
12	390	390	360	330	840	990	1140	1230	1170	1230	1140	1230	930	1020	690	360	390	360	1120
13	420	450	450	390	900	1050	1320	1410	1470	1470	1290	1470	1140	1140	780	420	480	450	1307
14	450	480	480	420	990	1170	1350	1170	1470	1470	1350	1560	1350	1230	840	480	540	510	1347
15	510	540	540	480	1140	1320	1350	1320	1470	1470	1350	1560	1350	1230	900	540	630	570	1380

	6	7	8	9	10	11	12	13	14	AVE
TOP	140	130	140	110	130	90	170	110	130	128.
MIDL	880	840	950	830	950	810	930	750	820	862.
BOTM	1180	1340	1300	1470	1470	1330	1530	1280	1200	1344
AV	733.	770	797.	803.	850	743.	877.	713.	717.	778.

RUN 1 - WT 3

(a)



DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
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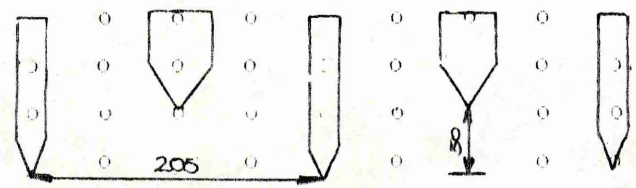
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	150	90	60	30	0		0		0		0		0		0	30	0	0	0
7	270	180	150	150	60	0	30	180	0	0	60	30	30	0	0	120	30	30	36.7
8	360	270	240	180	210	90	210	360	150	60	210	180	210	120	0	210	90	60	177.
9	450	390	330	270	420	390	450	570	420	330	480	360	390	450	420	330	120	90	427.
10	480	420	420	330	510	600	630	690	630	690	660	570	540	630	570	420	150	150	627.
11	510	450	480	390	570	660	720	840	780	840	780	750	660	690	660	510	150	180	747.
12	510	480	540	480	600	720	780	960	840	900	870	870	720	720	720	570	180	240	820
13	480	510	660	570	630	780	750	1050	870	990	930	960	900	780	900	660	180	270	890
14	540	630	810	720	690	930	810	1260	960	1110	1020	1080	1080	870	1080	780	150	240	1013
15	690	720	930	900	900	1110	960	1260	1110	1380	1260	1230	1260	1080	1260	1050	180	270	1183
TOP						160	230	370	190	130	250	190	210	190					213.
MIDL						660	710	830	750	810	770	730	640	680					731.
BOTM						940	840	1190	980	1160	1070	1090	1080	910					1029
AV						587.	593.	797.	640	700	697.	670	643.	593.					658.

RUN 2 - WT 1

(b)



DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	.	0	0	0		0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0		0	0	0		0	0	0		0	0	0	0	0
4	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0
6	60	60	0	60	0		0		0		0		0		[redacted]	[redacted]	60	0	0
7	[redacted]	[redacted]	90	[redacted]	60	0	0	30	30	30	0	0	60	30	[redacted]	[redacted]	[redacted]	0	20
8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	30	30	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	90	[redacted]	[redacted]	[redacted]	0	110
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	263.
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	517.
11	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	810	[redacted]	870	810	810	[redacted]	810	[redacted]	[redacted]	[redacted]	[redacted]	690
12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	900	[redacted]	1050	930	1110	1050	1020	900	870	[redacted]	[redacted]	[redacted]	[redacted]	957.
13	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1020	930	1170	1140	1230	1170	1170	1080	960	[redacted]	[redacted]	[redacted]	[redacted]	1097
14	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1110	1020	1320	1260	1380	1290	1260	1230	1050	810	[redacted]	[redacted]	[redacted]	1213
15	[redacted]	[redacted]	[redacted]	[redacted]	900	1350	1140	1380	1500	1230	1560	[redacted]	1380	1200	990	[redacted]	[redacted]	[redacted]	1340

	6	7	8	9	10	11	12	13	14	AVE
TOP	80	50	180	140	120	140	170	170	130	131.
MIDL	730	540	810	500	860	800	790	710	750	721.
BOTM	1160	1030	1290	1300	1280	1340	1250	1230	1070	1217
AV	657.	540	760	647.	753.	760	737.	703.	650	690.

RUN 2 WT2

(a)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0
6	90	120	60	120	30		0	205	0		0		0		60	120	60	60	0
7	150	210	150	210	120	0	30	0	30	0	30	0	30	0	120	210	150	180	13.3
8	210	240	180	270	150	30	90	60	90	30	90	90	120	30	210	240	210	270	70
9	270	300	210	300	270	150	210	210	180	150	180	300	240	150	300	300	240	330	197.
10	300	360	270	360	450	360	390	360	390	390	420	480	420	360	450	330	300	360	397.
11	360	360	300	360	570	720	600	510	630	810	690	690	660	720	570	390	330	420	670
12	360	390	360	420	660	870	960	1020	930	1140	1020	1020	930	930	690	450	390	510	980
13	510	510	420	450	810	960	1170	1260	1200	1290	1260	1260	1350	1020	840	510	420	540	1197
14	630	720	480	510	870	1080	1410	1260	1470	1440	1440	1440	1410	1200	990	630	570	600	1350
15	870	990	630	660	1200	1200	1410	1260	1470	1440	1440	1440	1410	1350	1320	840	810	750	1380

	6	7	8	9	10	11	12	13	14	AVE
TOP	60	110	90	100	60	100	130	130	60	93.3
MIDL	650	650	630	650	780	710	730	670	670	682.
BOTM	1080	1330	1260	1380	1390	1380	1380	1390	1190	1309
AV	597.	697.	660	710	743.	730	747.	730	640	695.

RUN2 - WT3

50

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0		0	0	0		0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
3	0	0	0	0	0		0		0		0		0		0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
5	60	0	0	0	60		0	30	0		0		0		0	0	0	0	3.33
6	240	210	180	210	150		60	30	30		60	60	30		120	240	180	60	30
7	330	360	330	300	300	0	240	210	120	30	210	210	120	0	240	390	300	240	127.
8	510	450	480	420	450	240	420	390	330	330	360	360	270	240	390	450	420	360	323.
9	690	540	540	510	690	570	660	570	510	630	600	600	450	540	450	510	450	510	560
10	690	570	540	540	720	750	840	720	660	810	780	780	540	780	480	540	480	540	727.
11	720	630	570	600	600	810	930	870	810	900	840	840	720	810	480	540	480	630	830
12	780	720	600	630	630	870	990	930	930	960	930	930	840	870	480	600	480	660	907.
13	810	780	660	660	660	930	1080	1020	1020	1020	1020	1020	1020	930	510	690	510	720	1000
14	930	930	750	750	780	1020	1170	1050	1200	1140	1170	1170	1170	1020	630	780	630	810	1117
15	1290	1260	960	960	990	1200	1140	1200	1260	1350	1260	1260	1290	1170	660	1050	810	840	1240
TOP						270	440	390	320	330	390	350	280	260					337.
MIDL						810	920	840	800	890	850	760	700	820					821.
BOTM						1050	1130	1090	1160	1170	1150	1120	1160	1040					1119
AV						710	830	773.	760	797.	797.	743.	713.	707.					759.

205

75

RUN3 - WT 1

(c)

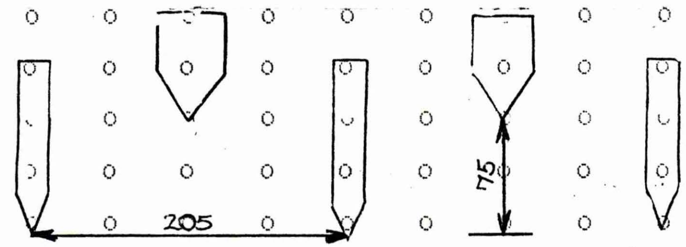
DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0		0	0	0		0		0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	60	60	60	60	0		0	205	0		0	0	0		30	0	0	0	0
6	[redacted]	[redacted]	[redacted]	[redacted]	60		30	0	30		30	30	0	[illegible]	[redacted]	[redacted]	90	[redacted]	16.7
7	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	30	[redacted]	[redacted]	90	60	[redacted]	[redacted]	60	30	[redacted]	[redacted]	[redacted]	[redacted]	90
8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	217.
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	463.
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	840	[redacted]	810	[redacted]	930	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	777.
11	[redacted]	[redacted]	[redacted]	[redacted]	810	1080	1020	1050	1050	1230	960	930	900	1050	[redacted]	[redacted]	[redacted]	[redacted]	1030
12	[redacted]	[redacted]	810	[redacted]	900	1170	1170	1290	1290	1470	1170	1170	1050	1260	810	[redacted]	[redacted]	[redacted]	1227
13	[redacted]	[redacted]	960	[redacted]	960	1230	1230	1500	1440	1470	1350	1440	1230	1470	930	[redacted]	[redacted]	[redacted]	1373
14	[redacted]	900	1080	[redacted]	1050	1320	1320	1650	1680	1470	1500	1530	1440	1620	1050	[redacted]	[redacted]	[redacted]	1503
15	930	1020	1020	1020	1380	1470	1410	1650	1680	1470	1740	1740	1710	1710	1290	870	[redacted]	930	1620

75

	6	7	8	9	10	11	12	13	14	AVE
TOP	220	320	350	240	230	290	270	220	170	257.
MIDL	1030	990	1050	1030	1210	960	940	880	1010	1011
BOTM	1340	1320	1600	1600	1470	1530	1570	1460	1600	1499
AV	863.	877.	1000	957.	970	927.	927.	853.	927.	922.

RUN 3 WT 2

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	90	90	0	0		0		0	0	0		0	0	0	0	0	0	0
7	120	180	180	120	60		0	0	0		0	0	0		90	90	30	150	0
8	210	210	330	180	150	0	90	120	90	0	90	90	30	90	180	210	150	270	66.7
9	360	270	390	300	330	90	300	240	210	90	240	90	180	90	360	300	210	390	190
10	390	360	480	420	540	420	480	480	480	300	480	390	420	390	540	420	330	480	437.
11	450	420	570	540	690	780	840	840	780	840	810	690	810	690	750	510	480	540	787.
12	540	480	600	630	870	1080	1140	1230	1140	1260	1170	960	1110	990	930	660	600	600	1120
13	600	540	720	750	990	1230	1380	1470	1230	1500	1470	1320	1440	1230	1050	750	720	690	1367
14	720	720	900	900	1200	1380	1470	1470	1650	1530	1710	1500	1650	1410	1200	900	810	780	1497
15	990	930	1320	1110	1350	1350	1380	1470	1380	1520	1660	1680	1650	1620	1380	1110	1020	960	1527



TOP	30	130	120	100	30	110	120	70	60		85.6
MIDL	760	820	850	800	800	820	710	780	690	RUN 3 UT 3	781.
BOTM	1320	1410	1470	1320	1520	1680	1440	1590	1420		1463
AV	703.	787.	813.	740	783.	870	757.	813.	723.		777.

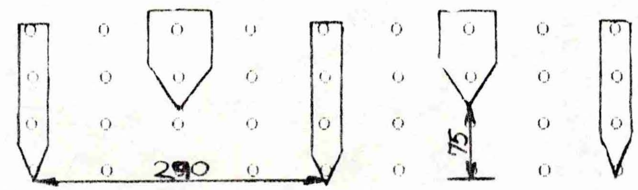
(P)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	120	120	120	240	0	0	60	0	90	0	60	0	0	0	90	120	150	120	23.3
8	240	330	210	330	120	0	270	210	210	0	180	150	90	0	210	300	270	180	123.
9	360	390	330	390	330	240	480	330	360	180	330	300	270	210	360	360	330	240	300
10	420	420	390	420	510	540	630	540	570	510	420	420	450	420	480	480	390	300	500
11	450	480	420	480	570	660	750	630	690	690	600	510	600	630	570	570	420	330	640
12	510	510	480	570	630	720	810	780	750	780	630	630	690	750	630	630	450	360	727.
13	540	600	570	720	720	810	870	840	870	870	780	720	780	840	720	720	510	450	820
14	600	720	720	990	840	960	960	930	990	1050	900	930	870	930	840	840	630	510	947.
15	780	930	840	1140	930	1110	1110	1110	1230	750	1170	1200	1050	1080	990	990	840	720	1090

	6	7	8	9	10	11	12	13	14	AVE
TOP	80	270	180	220	60	190	150	120	70	149.
MIDL	640	730	650	670	660	550	520	580	600	622.
BOTM	960	980	960	1030	890	950	950	900	950	952.
AV	560	660	597.	640	537.	563.	540	533.	540	574.

RUN 4 - WT 1

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0		0		0		0		0		0	0	0	0	0
6	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	60	30	30	0
7	[redacted]	[redacted]	0	90	0	0	30	90	0	0	0	0	30	0	[redacted]	[redacted]	[redacted]	[redacted]	16.7
8	[redacted]	[redacted]	[redacted]	[redacted]	60	0	[redacted]	[redacted]	0	90	[redacted]	[redacted]	[redacted]	0	[redacted]	[redacted]	[redacted]	[redacted]	96.7
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	233.
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	447.
11	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	720	720	[redacted]	840	[redacted]	750	720	660	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	727.
12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	840	840	870	1050	840	900	840	840	930	[redacted]	[redacted]	[redacted]	[redacted]	883.
13	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	900	960	1080	1200	1020	1020	930	990	990	[redacted]	[redacted]	[redacted]	[redacted]	1010
14	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1020	1050	1290	1410	1140	1170	1080	1110	1140	870	780	[redacted]	[redacted]	1157
15	[redacted]	[redacted]	1000	[redacted]	900	1230	1200	1470	[redacted]	1410	1380	1320	1320	1410	1020	990	960	630	1370
TOP						40	140	210	40	100	150	170	130	60					116.
MIDL						660	630	680	790	650	720	700	640	700					686.
BOTM						1050	1070	1280	1410	1190	1180	1110	1140	1180					1179
AV						583.	613.	723.	747.	647.	683.	660	637.	647.					660.



RUN 4 WT 2

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	60	90	120	180	0	0	0	0	0	0	0	0	0	0	90	150	120	150	0
8	180	180	180	240	30	0	30	60	0	0	60	60	90	0	120	270	240	240	33.3
9	240	210	240	360	150	60	90	240	120	60	150	210	210	60	240	390	300	270	133.
10	330	390	330	420	240	270	270	420	210	210	360	420	390	210	390	450	390	390	307.
11	450	510	390	480	420	570	480	660	420	630	660	630	570	480	600	570	450	480	567.
12	600	630	480	540	630	870	750	870	690	1050	900	870	840	780	780	600	570	540	847.
13	660	780	510	630	840	1050	1020	1110	1020	1260	1140	1050	1080	990	900	690	660	660	1080
14	720	840	660	720	990	1230	1290	1260	1290	1470	1350	1260	1260	1200	990	750	750	780	1290
15	840	1020	840	960	1140	1410	1530	1530	1410	1500	1500	1470	1470	1380	1200	870	930	960	1467
TOP						20	40	100	40	20	70	90	100	20					55.6
MIDL						570	500	650	440	630	640	640	600	490					573.
BOTM						1230	1280	1300	1240	1410	1330	1260	1270	1190					1279
AV						607.	607.	683.	573.	687.	680	663.	657.	567.					636.

290

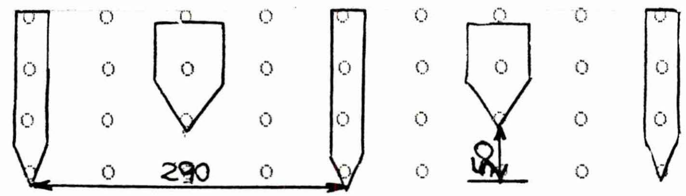
75

RUN 4 - WT 3

(P)

(e)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	30	0		0		0	0	0		0		30	30	0	0	0
7	120	120	90	150	60	0	30	0	60	0	30	0	60	0	120	120	60	90	20
8	240	240	210	270	180	90	210	270	210	120	240	240	240	0	240	240	150	210	180
9	330	360	300	420	360	420	390	450	450	480	450	450	420	390	450	360	240	300	433.
10	480	480	420	480	510	630	600	570	630	720	690	690	630	630	660	480	300	360	643.
11	570	630	450	540	690	630	810	690	840	780	870	870	810	750	750	630	450	420	783.
12	720	720	510	630	810	690	990	720	990	780	930	930	900	750	840	720	540	450	853.
13	810	810	480	690	900	720	1080	780	1080	810	1050	1050	930	810	900	780	600	510	923.
14	900	870	600	810	990	810	1140	840	1170	900	1110	1110	990	900	1050	900	660	600	997.
15	1080	1080	750	1050	1050	930	1140	960	1350	1020	1290	1290	1200	1080	1290	1170	810	840	1140
TOP						170	210	240	240	200	240	230	240	130					211.
MIDL						650	800	660	820	760	830	830	780	710					760
BOTM						820	1120	860	1200	910	1150	1150	1040	930					1020
AV						547.	710	587.	753.	623.	740	737.	687.	590					664.



RUN 5 - WT 1

(e)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	30		0	290	0		0	R	30		30	0	0	0	3.33
6	60	60	[redacted]	[redacted]	60	0	30	0	30	0	30	0	60	0	60	[redacted]	90	90	16.7
7	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	60	0	90	0	[redacted]	0	[redacted]	0	[redacted]	[redacted]	[redacted]	[redacted]	43.3
8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	[redacted]	30	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	60	[redacted]	[redacted]	[redacted]	[redacted]	153.
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	383.
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	600	[redacted]	630	690	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	660
11	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	930	750	870	990	1110	990	900	870	840	[redacted]	[redacted]	[redacted]	[redacted]	917.
12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1050	930	1050	1200	1290	1140	1020	1080	990	840	[redacted]	[redacted]	[redacted]	1083
13	[redacted]	[redacted]	[redacted]	[redacted]	990	1050	1110	1110	1350	1470	1260	1200	1230	1050	930	[redacted]	[redacted]	[redacted]	1203
14	[redacted]	[redacted]	[redacted]	900	1140	1140	1230	1440	1470	1620	1320	1410	1350	1290	1050	[redacted]	[redacted]	[redacted]	1363
15	[redacted]	930	1020	1080	1110	1260	1230	1440	1710	1710	1470	[redacted]	1470	1380	1320	990	[redacted]	960	1473

	6	7	8	9	10	11	12	13	14	AVE
TOP	70	200	140	240	170	310	250	260	100	193.
MIDL	860	740	850	960	1040	970	890	860	810	887.
BOTM	1150	1190	1330	1510	1600	1350	1400	1350	1240	1347
AV	693.	710	773.	903.	937.	877.	847.	823.	717.	809.

RUN5 · WT 2

(e)

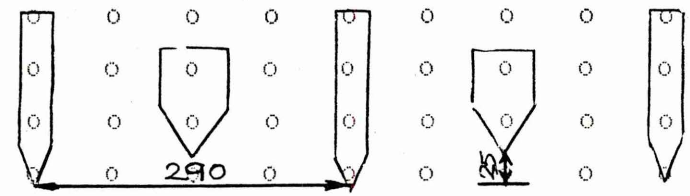
DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0
6	90	0	240	240	30	0	0	0	30	30	30	0	30	0	90	150	60	150	13.3
7	210	180	390	390	90	0	30	0	90	0	90	0	90	0	180	240	150	300	33.3
8	240	300	510	480	150	60	120	270	150	120	180	90	180	30	270	330	240	420	133.
9	300	360	540	540	270	300	330	540	270	360	300	420	330	120	360	450	300	510	330
10	360	420	570	600	450	600	570	750	450	690	570	660	540	450	570	540	420	570	587.
11	420	480	600	660	600	960	870	1080	780	1140	780	960	840	900	780	660	510	630	923.
12	480	600	660	750	750	1200	1110	1290	1050	1350	1140	1230	1170	1170	930	780	630	690	1190
13	570	690	750	840	840	1290	1350	1500	1320	1470	1320	1410	1380	1260	1020	870	720	810	1367
14	690	780	990	930	930	1410	1470	1590	1500	1530	1470	1530	1530	1350	1170	960	750	870	1487
15	870	1050	1110	1170	1170	1530	1470	1590	1590	1590	1620	1650	1680	1500	1410	1260	900	1080	1580

	6	7	8	9	10	11	12	13	14	AVE
TOP	120	160	270	170	160	190	170	200	50	166.
MIDL	920	850	1040	760	1060	830	950	850	840	900
BOTM	1410	1430	1560	1470	1530	1470	1530	1530	1370	1478
AV	817.	813.	957.	800	917.	830	883.	860	753.	848.

RUN5-WT3

(F)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	150	120	150	210	60	0	90	0	60	0	60	0	120	0	120	210	90	0	36.7
7	300	300	270	330	210	0	240	0	240	0	270	0	270	0	270	360	210	150	113.
8	420	390	360	390	450	360	480	390	450	300	510	390	510	0	450	450	300	240	377.
9	480	450	450	450	540	600	690	660	750	630	750	600	720	450	600	510	360	330	650
10	540	510	480	510	600	660	810	840	930	870	810	720	810	630	660	600	450	390	787.
11	570	570	540	570	630	720	900	930	930	900	930	810	840	690	720	630	510	450	850
12	600	630	600	570	720	780	960	1020	960	990	930	840	900	780	780	690	570	510	907.
13	660	720	660	660	810	870	1050	1140	1050	990	990	930	1020	840	840	750	630	540	987.
14	840	840	780	810	930	990	1200	1230	1170	1080	1080	1080	1200	960	1020	900	690	570	1110
15	1140	990	930	1110	1140	1230	1410	1380	1380	1290	1260	1290	1470	1140	1230	1140	810	750	1317



	6	7	8	9	10	11	12	13	14	AVE
TOP	320	470	350	480	310	510	330	500	150	380
MIDL	720	890	930	940	920	890	790	850	700	848.
BOTM	1030	1220	1250	1200	1120	1110	1100	1230	980	1138
AV	690	860	843.	873.	783.	837.	740	860	610	789.

RUN 6 - LST 1

(f)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.67
6	30	0	60	[redacted]	30	0	30	0	60	0	0	0	30	[redacted]	90	60	0	0	26.7
7	[redacted]	0	[redacted]	[redacted]	90	0	60	0	[redacted]	30	60	0	[redacted]	[redacted]	[redacted]	[redacted]	90	[redacted]	76.7
8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	300	60	270	[redacted]	[redacted]	0	[redacted]	[redacted]	270	[redacted]	[redacted]	270	223.
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	600	[redacted]	600	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	507.
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	690	840	900	870	[redacted]	840	720	870	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	763.
11	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	840	1050	1140	1080	1140	1080	1140	1080	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1023
12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	930	1200	1290	1290	1320	1290	1320	1200	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1177
13	[redacted]	[redacted]	[redacted]	[redacted]	810	990	1290	1440	1410	1470	1410	1410	1350	840	[redacted]	[redacted]	[redacted]	[redacted]	1290
14	[redacted]	[redacted]	[redacted]	810	960	1140	1380	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1440	990	840	720	630	720	1390
15	870	840	870	870	1050	1320	1410	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1260	1050	870	810	930	1530

	6	7	8	9	10	11	12	13	14	AVE
TOP	170	300	170	330	200	320	160	380	390	269.
MIDL	820	1030	1110	1080	1010	1070	1060	1050	660	988.
BOTM	1150	1360	1540	1520	1520	1540	1510	1460	1030	1403
AV	713.	897.	940	977.	910	977.	910	963.	693.	887.

RUN6 - WT2

(F)

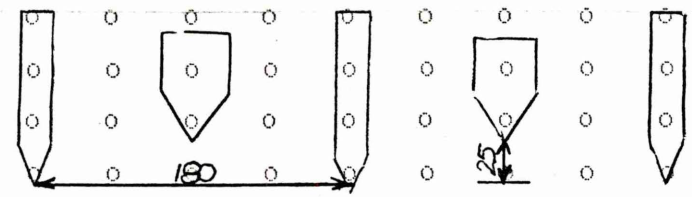
DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	60	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	210	180	120	90	60	0	0	0	30	0	30	0	30	0	0	120	0	0	10
7	300	270	240	180	150	30	180	0	90	0	60	30	90	0	120	150	90	60	53.3
8	390	390	300	300	300	150	480	0	210	30	240	0	120	0	210	270	180	180	137.
9	480	540	390	390	510	360	840	210	450	180	510	0	330	60	390	360	270	300	327.
10	600	630	480	540	750	660	1170	600	720	510	870	390	570	330	570	450	330	390	647.
11	690	690	510	630	960	900	1500	870	1170	930	1170	810	900	660	780	540	390	480	990
12	720	780	570	690	1080	1050	1530	1170	1500	1200	1500	1110	1260	900	900	630	420	540	1247
13	810	870	660	750	1200	1230	1230	1470	1470	1440	1650	1200	1470	1050	1020	750	450	600	1357
14	900	990	750	840	1380	1380	1380	1380	1380	1440	1650	1590	1590	1170	1140	900	510	780	1440
15	1080	1470	930	1050	1620	1500	1500	1500	1500	1440	1980	1680	1680	1380	1350	1200	600	990	1573

	6	7	8	9	10	11	12	13	14	AVE
TOP	180	500	70	250	70	270	10	180	20	172.
MIDL	870	1400	880	1130	880	1180	770	910	630	961.
BOTM	1370	1370	1450	1450	1440	1760	1490	1580	1200	1457
AV	807.	1090	800	943.	797.	1070	757.	890	617.	863.

RUN6 - WT3

(9)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	60	120	90	120	120	0	120	0	0	0	0	0	150	0	0	120	60	0	30
8	180	240	240	270	300	210	450	510	270	390	270	510	300	270	150	270	150	120	353.
9	330	450	390	390	450	570	660	900	720	750	540	750	660	540	390	360	300	390	677.
10	480	570	540	480	660	810	870	1050	1080	1050	900	900	840	720	570	570	480	570	913.
11	690	720	780	600	870	900	1080	1170	1290	1170	1110	990	1050	810	810	690	630	750	1063
12	870	870	1020	750	1080	990	1200	1320	1380	1320	1290	1020	1260	930	1050	810	750	990	1190
13	990	690	1140	870	1290	1140	1350	1410	1500	1470	1350	1140	1410	1050	1290	990	900	1230	1313
14	1080	1170	1200	990	1320	1230	1410	1500	1590	1590	1470	1260	1530	1200	1500	1110	870	1410	1420
15	1290	1470	1410	1260	1140	1440	1560	1560	1770	1740	1680	1350	1620	1380	1500	1500	1200	1530	1567



	6	7	8	9	10	11	12	13	14	AVE
TOP	260	410	470	330	380	270	420	370	270	353.
MIDL	900	1050	1180	1250	1180	1100	970	1050	820	1056
BOTM	1270	1440	1490	1620	1600	1500	1250	1520	1210	1433
AV	810	967.	1047	1067	1053	957.	880	980	767.	947.

RUN 7- WT 1

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0		0	0	0		0	0	0		0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	[illegible]	60		0	180	0		0	10	0		0	0	0	0	0
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	30	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	0	3.33
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	0	[illegible]	0	90	0	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	66.7
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	390	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	357.
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	720	600	[illegible]	870	[illegible]	780	[illegible]	870	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	687.
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	780	870	1050	1170	1080	1110	1020	1140	990	940	[illegible]	[illegible]	[illegible]	1023
11	[illegible]	[illegible]	[illegible]	[illegible]	720	930	1050	1260	1350	1440	1260	1320	1320	1260	990	660	[illegible]	[illegible]	1243
12	[illegible]	[illegible]	[illegible]	[illegible]	810	1020	1230	1380	[illegible]	[illegible]	[illegible]	[illegible]	1410	1350	1050	[illegible]	[illegible]	600	1403
13	[illegible]	[illegible]	[illegible]	[illegible]	870	1110	1320	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1440	1140	690	[illegible]	[illegible]	1547
14	[illegible]	[illegible]	[illegible]	[illegible]	990	1140	1410	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1290	840	[illegible]	[illegible]	1623
15	[illegible]	900	[illegible]	[illegible]	1170	1140	1470	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1410	960	[illegible]	630	1667

	6	7	8	9	10	11	12	13	14	AVE
TOP	200	390	340	500	290	440	380	520	270	370
MIDL	910	1050	1230	1360	1390	1290	1290	1290	1200	1223
BOTM	1130	1400	1650	1830	1840	1820	1720	1610	1510	1612
AV	747.	947.	1073	1230	1173	1183	1130	1140	993.	1069

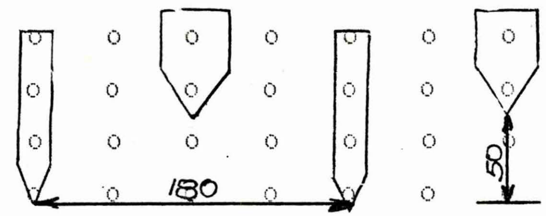
RUN 7. WT 2

(9)

(6)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	30	0	0
6	180	210	180	210	90	0	0	0	0	0	0	0	30	0	150	90	180	90	3.33
7	420	420	330	390	120	60	0	30	0	0	120	0	120	60	300	330	360	300	43.3
8	630	600	450	510	300	240	0	150	0	60	360	0	450	450	540	510	510	510	190
9	780	720	600	630	570	540	0	450	120	240	750	450	690	780	660	630	630	600	447.
10	840	810	660	750	960	900	720	990	810	900	930	660	990	990	840	690	690	630	877.
11	870	810	690	840	1140	1230	1230	1380	1140	1230	1170	990	1290	1230	960	690	750	690	1210
12	870	840	750	900	1290	1470	1500	1830	1500	1770	1530	1530	1650	1380	1020	720	750	720	1573
13	870	870	780	960	1380	1620	1860	1920	1920	1920	1800	1830	1800	1530	1080	810	810	780	1800
14	930	930	870	1050	1350	1650	1890	1920	1920	1920	1860	1920	1830	1590	1290	900	870	780	1833
15	1050	1080	930	1260	1590	1560	1920	1920	1950	1920	1860	1680	1890	1740	1410	1020	990	900	1827
TOP						280	0	210	40	100	410	150	420	430					227.
MIDL						1200	1150	1400	1150	1300	1210	1060	1310	1200					1220
BOTM						1610	1890	1920	1930	1920	1840	1810	1840	1620					1820
AV						1030	1013	1177	1040	1107	1153	1007	1190	1083					1089

RUN 7- WT 3



DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	90	150	120	150	60	30	30	30	0	0	60	0	30	30	90	150	60	30	23.3
7	210	240	210	270	150	30	30	30	60	0	120	30	90	30	150	240	180	150	46.7
8	270	300	300	330	300	180	180	330	240	120	300	300	240	120	300	270	270	240	223.
9	330	330	300	330	420	540	540	570	600	570	630	540	540	510	510	360	300	270	560
10	360	390	360	390	570	750	750	750	840	780	840	780	750	720	600	450	330	300	773.
11	390	450	390	420	630	810	810	870	1020	930	990	930	900	840	660	540	390	360	900
12	420	450	450	420	630	840	840	960	1110	1050	1110	1020	960	870	780	660	450	420	973.
13	420	510	510	480	690	870	870	990	1140	1110	1230	1110	1050	930	840	720	570	450	1033
14	510	570	570	600	750	990	990	1080	1200	1290	1380	1230	1080	990	960	870	630	510	1137
15	570	780	720	780	930	1140	1140	1170	1350	1530	1500	1350	1230	1140	1170	870	690	630	1283
TOP						250	250	310	300	230	350	290	290	220					277.
MIDL						800	800	860	990	920	980	910	870	810					882.
BOTM						1000	1000	1080	1230	1310	1370	1230	1120	1020					1151
AV						683.	683.	750	840	820	900	810	760	683.					770.

RUN 8 - WT 1

(4)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	90	[redacted]	[redacted]	[redacted]	60		0	180	0		[redacted]	50	0		60	[redacted]	90	0	13.3
7	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	30	0	60	0	[redacted]	0	30	0	[redacted]	[redacted]	[redacted]	[redacted]	43.3
8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	60	[redacted]	[redacted]	[redacted]	0	[redacted]	[redacted]	[redacted]	30	[redacted]	[redacted]	[redacted]	[redacted]	173.
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	870	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	450
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	810	[redacted]	930	[redacted]	1080	[redacted]	870	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	763.
11	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	930	1080	810	1200	870	1380	930	1080	870	[redacted]	[redacted]	[redacted]	[redacted]	1017
12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1110	1230	1020	1380	1170	[redacted]	1230	1320	1080	840	[redacted]	[redacted]	[redacted]	1233
13	[redacted]	[redacted]	[redacted]	[redacted]	840	1230	1380	1290	[redacted]	1380	[redacted]	1410	1470	1230	960	[redacted]	[redacted]	[redacted]	1410
14	[redacted]	[redacted]	[redacted]	[redacted]	930	1350	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1320	1050	840	[redacted]	[redacted]	1557
15	[redacted]	[redacted]	[redacted]	[redacted]	1230	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1320	1020	[redacted]	[redacted]	1707

	6	7	8	9	10	11	12	13	14	AVE
TOP	150	240	160	290	70	560	160	270	100	222.
MIDL	920	1040	790	1170	880	1340	940	1090	870	1004
BOTM	1380	1460	1500	1670	1610	1820	1570	1650	1360	1558
AV	817.	913.	817.	1043	853.	1240	890	1003	777.	928.

RUN 8 WT 2

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	60	120	120	30	[illegible]	0	180	0	0	0	[illegible]	0	0	60	180	90	60	0
7	210	210	180	270	120	0	0	0	0	0	0	0	30	0	120	300	210	210	3.33
8	300	300	270	300	210	30	90	120	60	0	90	120	120	30	210	360	270	270	73.3
9	330	360	270	360	360	210	300	270	240	300	240	360	300	150	420	480	360	360	263.
10	360	390	330	390	540	630	570	510	510	750	540	630	570	480	660	570	450	450	577.
11	360	420	360	420	750	960	870	780	780	1170	810	930	870	900	840	660	540	540	897.
12	450	480	420	480	870	1170	1170	1050	1290	1470	1350	1230	1200	1110	960	720	630	600	1227
13	480	600	480	540	960	1350	1380	1440	1650	1770	1650	1680	1500	1320	1080	750	720	630	1527
14	570	660	570	600	1080	1530	1620	1710	1830	1830	1830	1830	1770	1500	1200	840	780	690	1717
15	690	780	720	720	1230	1770	1770	1830	1830	1830	1830	1830	1890	1710	1470	1020	930	810	1810

	6	7	8	9	10	11	12	13	14	AVE
TOP	80	130	130	100	100	110	160	150	60	113.
MIDL	920	870	780	860	1130	900	930	880	830	900
BOTM	1550	1590	1660	1770	1810	1770	1780	1720	1510	1684
AV	850	863.	857.	910	1013	927.	957.	917.	800	899.

50

RUN 8 · WT 3

(5)

(c)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	60	0	0		0		0		0		0		90	90	60	30	0
7	90	150	180	60	0	30	60	30	0	60	60	60	0	0	120	180	180	120	33.3
8	210	240	240	150	120	150	210	90	120	150	210	120	90	180	270	270	270	210	147.
9	270	330	270	300	420	330	390	270	390	330	420	270	360	330	390	330	300	270	343.
10	330	390	270	450	720	480	630	510	690	630	660	540	570	480	510	390	360	330	577.
11	420	480	300	570	810	600	840	690	930	810	900	780	780	660	630	450	390	330	777.
12	510	570	330	660	870	780	960	870	1080	960	1020	930	840	870	780	510	420	330	923.
13	570	630	360	690	930	840	1080	1050	1200	1140	1110	1080	960	1020	840	630	450	360	1053
14	570	690	420	780	990	960	1200	1200	1320	1260	1230	1200	1020	1230	930	690	510	390	1180
15	630	780	420	900	1170	1020	1200	1350	1470	1410	1470	1410	1230	1530	1050	840	630	480	1343

TOP	170	220	130	170	180	230	150	150	170	WEIGHT 1 - RUN 9	174.
MIDL	620	810	690	900	800	860	750	730	670		759.
BOTM	940	1160	1200	1330	1270	1270	1230	1070	1260		1192
AV	577.	730	673.	800	750	787.	710	650	700		709.

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	30	60	90	60	0		0	180	0	0	30		0		60	[redacted]	60	[redacted]	3.33
7	[redacted]	[redacted]	[redacted]	[redacted]	60	0	0	90	30	0	[redacted]	90	30	0	[redacted]	[redacted]	[redacted]	[redacted]	43.3
8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	90	[redacted]	[redacted]	[redacted]	0	[redacted]	[redacted]	[redacted]	[redacted]	147.
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	360	360	330	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	380
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	810	630	680	630	930	810	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	723.
11	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	960	990	990	990	1080	1230	1020	1170	900	870	[redacted]	[redacted]	[redacted]	1037
12	[redacted]	[redacted]	[redacted]	[redacted]	930	1110	1200	1260	1320	1260	1440	1260	[redacted]	1170	1020	[redacted]	[redacted]	[redacted]	1283
13	[redacted]	[redacted]	[redacted]	[redacted]	1080	1200	1410	[redacted]	[redacted]	1440	[redacted]	1440	[redacted]	1290	1080	810	[redacted]	600	1450
14	[redacted]	[redacted]	[redacted]	[redacted]	1110	1290	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1380	1140	930	810	660	1550
15	[redacted]	990	[redacted]	[redacted]	1230	1440	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1290	1110	930	810	1637

75

	6	7	8	9	10	11	12	13	14		AVE
TOP	230	160	210	160	150	270	280	180	70	RUN 9 WT 2	190
MIDL	960	940	970	980	1090	1160	1000	1150	880		1014
BOTM	1310	1550	1580	1550	1560	1670	1600	1690	1400		1546
AV	833.	883.	920	897.	933.	1033	960	1007	783.		917.

(i)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	150	180	150	120	0	0	0	0	0	0	0	0	0	0	120	150	0	0	0
7	300	330	270	270	30	0	0	0	0	0	0	0	0	0	150	360	210	120	0
8	420	420	330	360	90	60	60	90	60	0	90	30	60	0	300	480	390	210	50
9	510	540	420	450	270	270	210	210	240	90	300	180	210	90	480	570	480	300	200
10	570	600	420	540	510	510	480	420	480	300	570	360	420	360	660	660	570	360	433.
11	570	630	480	600	750	840	750	720	780	630	900	630	720	690	840	720	630	420	740
12	630	690	540	630	900	1140	1080	1080	1200	1050	1260	960	1050	960	930	780	690	450	1087
13	690	720	570	690	990	1260	1380	1470	1470	1410	1650	1320	1440	1170	1020	810	750	510	1397
14	780	810	720	720	1170	1380	1590	1590	1710	1620	1650	1530	1650	1290	1110	840	810	510	1557
15	900	960	810	810	1350	1560	1590	1590	1710	1710	1740	1650	1740	1410	1320	960	900	570	1633

180

75

	6	7	8	9	10	11	12	13	14	AVE
TOP	110	90	100	100	30	130	70	90	30	83.3
MIDL	830	770	740	820	660	910	650	730	670	753.
BOTM	1400	1520	1550	1630	1580	1680	1500	1610	1290	1529
AV	780	793.	797.	850	757.	907.	740	810	663.	789.

RUN 9 · WT 3

(j)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0 190	0	0	0	0	0	0	60	0	0	60	0	0
7	150	90	120	150	0	0	90	0	0	60	90	0	0	210	180	180	180	0	34.3
8	240	270	210	300	90	0	240	150	0	150	210	0	90	330	330	210	270	0	107.
9	360	360	270	330	270	90	420	360	270	270	390	180	300	420	480	240	330	0	283.
10	390	420	300	420	450	480	600	570	570	510	600	540	540	450	510	270	390	0	553.
11	420	450	330	450	660	690	750	810	780	660	780	690	630	480	540	300	390	0	737.
12	480	480	360	450	720	720	840	900	870	780	870	780	750	510	570	330	450	0	823.
13	540	540	390	510	810	780	960	960	900	900	990	780	810	630	660	390	510	0	896.
14	630	600	450	570	930	840	1080	1110	960	990	1110	900	870	750	750	450	570	0	999.
15	750	720	510	660	1020	960	1230	1290	960	1140	1290	1020	1050	930	930	570	720	0	1127
TOP						30	250	170	90	160	230	60							141.
MIDL						630	730	760	740	650	750	670							704.
BOTM						860	1090	1120	940	1010	1130	900							1007
AV						507.	690	683.	590	607.	703.	543.							618.

RUN 10 - LOT 1

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0 190	0	0	0	0	0	0	0	0	0	0	0	0
6	[redacted]	[redacted]	30	[redacted]	0	0	30	60	0	30	0	30	60	0	0	0	0	0	21.4
7	[redacted]	[redacted]	90.	[redacted]	60	0	60	[redacted]	60	60	0	90	[redacted]	[redacted]	60	60	90	0	60
8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	[redacted]	[redacted]	[redacted]	[redacted]	0	[redacted]	[redacted]	[redacted]	90	[redacted]	[redacted]	0	124.
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	30	240	[redacted]	[redacted]	[redacted]	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	223.
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	330	690	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	369.
11	[redacted]	[redacted]	[redacted]	[redacted]	630	[redacted]	[redacted]	900	750	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	609.
12	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	660	720	1110	990	750	720	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	819.
13	[redacted]	[redacted]	[redacted]	[redacted]	840	900	930	1230	1170	930	930	870	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	994.
14	[redacted]	[redacted]	[redacted]	[redacted]	900	1020	1050	1410	1260	1110	1050	930	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	1119
15	[redacted]	[redacted]	[redacted]	[redacted]	1080	1140	1260	1260	1440	1320	1200	1080	810	[redacted]	[redacted]	[redacted]	[redacted]	0	1243

	6	7	8	9	10	11	12	AVE
TOP	10	140	310	150	140	0	200	136.
MIDL	420	530	900	740	550	410	640	599.
BOTM	1020	1080	1300	1290	1120	1060	960	1119
AV	483.	583.	837.	727.	603.	490	600	618.

RUN 10 CUT 2

(J)

EPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	120	90	60	60	0	0	0	0	0	0	30	0	0	0	0	0	0	0	4.29
7	210	210	180	180	30	0	60	30	0	30	60	0	60	150	90	0	0	0	25.7
8	330	300	300	300	90	0	90	90	0	120	150	0	120	210	180	120	60	0	64.3
9	390	420	390	450	180	0	180	150	30	150	240	0	240	390	330	210	210	0	107.
10	450	480	540	540	270	0	300	270	120	270	330	60	360	570	480	270	330	0	193.
11	540	570	600	570	510	120	480	450	300	420	510	270	540	720	630	420	420	0	364.
12	540	660	660	720	750	450	780	780	540	630	750	570	780	810	750	480	540	0	643.
13	600	780	750	810	1020	930	1050	1050	1110	960	1020	1020	1020	930	810	510	690	0	1020
14	660	900	810	900	1200	1350	1350	1410	1500	1260	1290	1260	1200	990	840	570	720	0	1346
15	750	1080	900	1020	1470	1350	1530	1530	1500	1470	1500	1320	1380	1170	930	690	810	0	1457

190

	6	7	8	9	10	11	12	AVE
TOP	0	110	90	10	100	150	0	65.7
MIDL	190	520	500	320	440	530	300	400
BOTM	1210	1310	1330	1370	1230	1270	1200	1274
AV	467.	647.	640	567.	590	650	500	580.

RUN 10 - WT 3

(j)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	60	0	0	0	0	0	0	0	0	60	30	90	30	0	0	0
7	60	120	90	180	30	0	0	0	0	0	0	30	150	150	180	120	0	0	0
8	180	210	180	270	150	90	60	150	210	60	30	210	270	210	300	240	0	0	100
9	270	300	240	300	360	360	360	330	510	300	450	390	330	330	390	330	0	0	385
10	330	360	300	360	510	660	600	660	870	600	690	570	450	360	480	420	0	0	680
11	390	390	330	390	660	870	810	1020	1320	1020	1050	720	540	420	570	540	0	0	1015
12	480	480	360	450	810	990	1020	1320	1590	1320	1260	870	570	480	630	660	0	0	1250
13	570	540	390	510	870	1110	1140	1560	1740	1470	1350	930	660	540	690	810	0	0	1395
14	630	570	450	540	930	1230	1200	1680	1830	1470	1410	1020	750	630	810	930	0	0	1470
15	750	630	540	540	1050	1350	1440	1680	1860	1740	1560	1170	960	750	930	1200	0	0	1605

	6	7	8	9	10	11	AVE
TOP	150	140	160	240	120	160	162.
MIDL	840	810	1000	1260	980	1000	982.
BOTM	1230	1260	1640	1810	1560	1440	1490
AV	740	737.	933.	1103	887.	867.	878.

RUN 11 - WT 1

(k)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	30	90	0	0	0	0	0	0	0	0	60	30	60	0	0	0	0
7	50	90	[illegible]	[illegible]	0	0	0	0	0	0	0	60	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0
8	[illegible]	[illegible]	270	[illegible]	90	0	60	60	0	90	[illegible]	[illegible]	300	240	270	240	0	0	60
9	[illegible]	[illegible]	350	360	300	[illegible]	240	390	330	390	[illegible]	270	390	330	360	300	0	0	335
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	750	[illegible]	720	780	[illegible]	[illegible]	390	[illegible]	360	0	0	645
11	[illegible]	[illegible]	[illegible]	[illegible]	690	870	840	1170	840	1020	960	690	600	[illegible]	[illegible]	[illegible]	0	0	950
12	[illegible]	600	[illegible]	630	900	1200	1230	[illegible]	1380	1380	1230	[illegible]	690	[illegible]	[illegible]	[illegible]	0	0	1340
13	[illegible]	720	[illegible]	690	1050	1440	[illegible]	1380	[illegible]	[illegible]	1440	1350	750	630	[illegible]	[illegible]	0	0	1550
14	[illegible]	870	630	720	1170	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	840	750	[illegible]	[illegible]	0	0	1800
15	[illegible]	990	750	840	1170	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	960	930	720	720	0	0	1880

	6	7	8	9	10	11	AVE
TOP	50	100	150	110	160	220	132.
MIDL	880	850	1180	930	1040	990	978.
BOTM	1560	1770	1800	1990	1660	1680	1743
AV	830	907.	1043	1010	953.	963.	951.

RUN 11 - WT 2

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	150	210	210	180	30	0	0	0	0	0	0	0	60	120	0	0	0	0	0
7	300	330	360	330	90	0	30	0	0	0	60	90	240	300	210	180	0	0	15
8	480	510	480	510	300	0	120	60	0	90	210	240	330	420	360	330	0	0	80
9	570	570	570	600	510	240	390	330	330	270	390	480	450	570	450	420	0	0	325
10	630	690	630	720	750	720	750	660	750	630	600	780	540	630	540	510	0	0	685
11	660	720	720	780	960	990	990	1050	1140	960	960	1080	600	660	630	630	0	0	1015
12	720	780	780	870	1140	1290	1290	1380	1470	1170	1290	1260	660	690	720	720	0	0	1315
13	750	870	810	960	1380	1680	1680	1890	2280	1650	1650	1500	720	720	840	840	0	0	1805
14	840	900	840	1020	1560	1860	1860	2010	2310	2010	1860	1560	810	780	930	960	0	0	1985
15	1050	990	960	1140	1710	2010	2010	2220	2310	2010	1950	1530	900	840	990	1080	0	0	2085

TOP	80	180	130	110	120	220	140
MIDL	1000	1010	1030	1120	920	950	1005
BOTM	1850	1850	2040	2300	1890	1820	1958
AV	977.	1013	1067	1177	977.	997.	1034

RUN 11 - WT3

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	30	0	0	0	0	0	0	0	0	120	60	30	0	0	0	0
7	150	150	180	150	30	0	0	0	0	60	0	90	270	270	180	150	0	0	10
8	300	300	270	270	180	120	120	210	180	210	240	300	390	390	270	240	0	0	180
9	420	390	330	300	360	450	390	540	480	540	540	510	480	480	330	330	0	0	490
10	510	480	390	390	570	750	690	840	840	840	780	690	540	540	420	360	0	0	790
11	540	540	480	420	690	930	900	1170	1170	1110	930	810	600	570	420	420	0	0	1035
12	600	570	540	480	810	990	1080	1440	1440	1230	1020	870	600	600	510	510	0	0	1200
13	630	600	630	540	870	1110	1200	1590	1590	1260	1050	930	660	630	510	600	0	0	1300
14	660	630	750	570	930	1260	1290	1740	1740	1350	1200	1020	720	660	630	690	0	0	1430
15	720	690	930	750	1020	1410	1410	1920	1920	1470	1350	1140	840	750	720	840	0	0	1580

	6	7	8	9	10	11	AVE
TOP	190	170	250	220	270	260	227.
MIDL	890	890	1150	1150	1060	910	1008
BOTM	1260	1300	1750	1750	1360	1200	1437
AV	780	787.	1050	1040	897.	790	891.

RUN 12 - WT 1

(7)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	60	[redacted]	90	0	0	0	0	0	0	0	0	90	30	0	0	0	0	0
7	[redacted]	[redacted]	[redacted]	[redacted]	30	0	0	0	0	0	0	90	[redacted]	[redacted]	[redacted]	30	0	0	0
8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	90	60	0	0	90	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	0	40
9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	0	215
10	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	690	[redacted]	[redacted]	[redacted]	[redacted]	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	0	480
11	[redacted]	[redacted]	[redacted]	[redacted]	840	900	900	870	840	870	810	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0	0	865
12	[redacted]	[redacted]	[redacted]	[redacted]	960	1080	1200	1290	1260	1140	1080	810	[redacted]	[redacted]	[redacted]	[redacted]	0	0	1175
13	[redacted]	[redacted]	810	[redacted]	1080	1200	1410	[redacted]	[redacted]	1440	1320	900	[redacted]	[redacted]	800	[redacted]	0	0	1425
14	[redacted]	[redacted]	960	810	1170	1380	[redacted]	[redacted]	[redacted]	[redacted]	1440	1020	[redacted]	[redacted]	[redacted]	[redacted]	0	0	1635
15	[redacted]	930	1170	1080	1320	1470	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1170	840	[redacted]	[redacted]	660	0	0	1750
TOP						170	110	70	50	110	0								85
MIDL						890	890	900	870	860	630								840
BOTM						1350	1570	1810	1780	1650	1460								1603
AV						803.	857.	927.	900	873.	697.								843.

265

30

RUN 12 - WT 2

(7)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	180	210	0	0	0	0	0	0	0	0	120	30	0	90	0	0	0
7	90	180	270	300	30	0	0	0	0	0	0	90	270	180	150	240	0	0	0
8	270	300	300	420	150	30	0	0	0	0	0	240	390	270	270	360	0	0	5
9	360	390	360	510	240	330	150	180	240	90	270	360	420	330	300	420	0	0	210
10	390	420	420	540	480	660	360	360	600	300	540	540	480	390	360	480	0	0	470
11	390	450	480	570	690	930	720	630	930	570	810	750	540	390	390	540	0	0	765
12	390	510	540	630	840	1200	1050	930	1440	900	1050	930	570	390	450	630	0	0	1095
13	420	570	570	690	990	1380	1470	1200	1890	1320	1410	1080	630	390	540	750	0	0	1445
14	420	660	630	750	1200	1560	1800	1710	2160	1710	1620	1230	720	390	600	900	0	0	1760
15	480	750	750	840	1380	1620	1800	1710	2160	2010	1830	1380	900	480	720	1110	0	0	1855

	6	7	8	9	10	11	AVE
TOP	120	50	60	80	30	90	71.7
MIDL	930	710	640	990	590	800	777.
BOTM	1520	1690	1540	2070	1680	1620	1687
AV	857.	817.	747.	1047	767.	837.	845.

RUN 12 - WT 3

APPENDIX VI

SOIL BIN DRAUGHT RESULTS

RUN NO	MEAN HORIS(KN)		
RUN1/1	.46316	RUN7/1	.53191
RUN1/2	.83158	RUN7/2	.93617
RUN1/3	1.2632	RUN7/3	1.3511
RUN2/1	.61053	RUN8/1	.61053
RUN2/2	.98947	RUN8/2	1.
RUN2/3	1.4526	RUN8/3	1.4105
RUN3/1	.65979	RUN9/1	.67347
RUN3/2	1.1340	RUN9/2	1.0612
RUN3/3	1.5773	RUN9/3	1.4592
RUN4/1	.69474	RUN10/1	.66667
RUN4/2	1.2105	RUN10/2	1.1979
RUN4/3	1.7368	RUN10/3	1.7396
RUN5/1	.68041	RUN11/1	.50515
RUN5/2	1.1649	RUN11/2	.88660
RUN5/3	1.6186	RUN11/3	1.3402
RUN6/1	.34043	RUN12/1	.52747
RUN6/2	.94681	RUN12/2	1.0110
RUN6/3	1.3830	RUN12/3	1.5714

APPENDIX VII

RESULTS FROM PHOTOGRAPH RANKING

Soil A	Ranking										Upper Limit 95%	Mean	Lower Limit 95%
Flat	8	8	8	8	7	8	8	8	8	7	8.04	7.8	7.55
Camb	7	7	4	3	8	7	3	6	7	8	7.12	6.0	4.88
235/2	4	3	6	7	4	4	7	7	6	5	6.16	5.3	4.43
235/0	6	6	3	4	6	6	6	3	4	6	5.77	5.0	4.22
235/4	3	5	5	6	5	5	4	5	5	4	5.17	4.7	4.22
190/4	5	4	7	5	2	3	5	4	2	2	4.86	3.9	2.94
275/4	2	2	2	2	3	2	2	2	3	3	2.58	2.3	2.02
Conv	1	1	1	1	1	1	1	1	1	1	1	1.0	1
Soil B													
235/4	8	7	7	7	8	8	8	7	7	7	7.69	7.4	7.1
190/4	7	6	8	6	7	7	7	8	8	6	7.47	7.0	6.53
Flat	6	8	6	8	5	6	4	6	6	8	7.07	6.3	5.52
275/4	5	5	3	5	6	4	6	5	5	5	5.4	4.9	4.39
235/0	3	4	5	3	3	5	5	4	4	3	4.4	3.9	3.39
Conv	4	3	4	4	4	2	3	3	3	4	3.79	3.4	3.0
Camb	2	2	2	2	2	3	2	2	2	2	3.08	2.9	2.72
235/2	1	1	1	1	1	1	1	1	1	1	1	1.0	1

	Ranking										Upper Limit 95%	Mean	Lower Limit 95%
Soil C													
190/4	8	8	8	8	8	8	7	8	8	8	8.08	7.9	7.72
275/4	7	7	7	5	7	7	8	6	7	7	7.25	6.8	6.34
Conv	6	5	5	7	6	4	6	7	5	6	6.24	5.7	5.15
235/4	5	6	6	6	5	6	5	5	6	5	5.81	5.5	5.19
235/2	3	4	4	4	4	5	4	4	4	4	4.27	4.0	3.73
Camb	4	3	2	3	3	3	2	3	3	3	3.23	2.9	2.57
Flat	1	2	3	2	2	2	1	2	2	1	2.16	1.8	1.43
235/0	2	1	1	1	1	1	3	1	1	2	1.81	1.4	0.99
Soil D													
Camb	8	8	8	8	8	8	8	8	8	8	8	8.0	8
235/4	7	7	4	5	6	7	6	5	6	6	6.47	5.9	5.32
190/4	5	6	5	6	7	5	5	7	7	7	6.54	6.0	5.45
Conv	6	3	7	7	3	6	7	6	5	2	6.28	5.2	4.11
Flat	4	4	6	3	5	4	4	3	3	5	4.67	4.1	3.52
235/2	2	2	3	4	4	3	2	4	4	4	3.73	3.2	2.67
235/0	3	5	2	2	2	2	3	2	2	3	3.16	2.6	2.04
275/4	1	1	1	1	1	1	1	1	1	1	1	1.0	1
Soil E													
235/2	8	7	6	8	8	6	8	8	8	6	7.85	7.3	6.75
190/4	6	6	8	6	7	8	7	7	6	8	7.41	6.9	6.39
235/0	7	5	7	7	6	7	6	6	7	7	6.91	6.5	6.09
235/4	5	8	5	5	5	5	5	5	5	5	5.85	5.3	4.75
275/4	4	4	4	4	4	4	4	4	4	4	4	4.0	4
Conv	3	3	3	3	3	3	3	3	3	3	3	3.0	3
Flat	2	2	2	2	2	2	2	2	2	2	2	2.0	2
Camb	1	1	1	1	1	1	1	1	1	1	1	1.0	1

											Upper Limit 95%	Mean	Lower Limit 95%
Soil G													
235/4	8	8	5	8	8	8	7	7	7	6	7.79	7.2	6.6
190/4	7	3	8	7	6	7	8	8	8	8	7.91	7.0	6.09
235/2	6	7	7	6	7	6	4	4	6	5	6.46	5.8	5.14
275/4	5	6	6	5	5	5	3	3	4	7	5.64	4.9	4.15
Conv	4	2	4	4	2	3	5	5	5	3	4.37	3.7	3.03
Camb	2	5	2	2	1	4	6	6	3	2	4.36	3.3	2.24
235/0	3	4	3	3	3	1	1	2	1	4	3.18	2.5	1.82
Flat	1	1	1	1	4	2	2	1	2	1	2.16	1.6	1.04
Soil H													
190/4	8	8	8	7	8	6	7	7	5	5	7.59	6.9	6.21
Camb	7	7	7	8	7	8	8	4	4	4	7.39	6.4	5.41
235/4	5	6	5	6	6	4	4	8	8	8	6.19	6.0	5.09
235/2	6	5	4	5	4	5	5	6	6	6	5.66	5.2	4.74
235/0	4	2	6	4	2	7	6	5	7	7	6.13	5.0	3.87
275/4	3	3	3	3	5	2	2	2	3	3	3.41	2.9	2.39
Flat	2	4	2	2	2	3	3	3	2	2	3.01	2.6	2.19
Conv	1	1	1	1	1	1	1	1	1	1	1	1.0	1

APPENDIX VIII

ANGLED PRESS PENETROMETER PROFILES

UNITS ARE IN kN/m²

a)	0°	(150mm spacing)	
b)	0°	(190mm	")
c)	0°	(380mm	")
d)	5°	(190mm	")
e)	10°	("	")
f)	15°	("	")
g)	20°	("	")

(a)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	120	180	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0
9	30	270	360	0	0	0	0	0	0	0	0	0	0	0	30	150	0	240	0
10	210	390	450	120	60	0	30	30	60	0	60	60	60	0	120	300	240	420	33.3
11	240	480	570	390	210	30	210	90	300	0	210	240	420	90	330	390	360	540	177.
12	360	540	630	780	630	450	810	420	840	330	600	780	840	690	660	480	450	630	640
13	450	630	690	1020	1080	990	1230	840	1230	1140	1230	1200	1230	1140	780	540	480	660	1137
14	570	660	720	1050	1290	1260	1530	1290	1290	1470	1410	1530	1410	1320	930	570	510	750	1390
15	630	720	780	1080	1380	1320	1530	1530	1470	1470	1530	1680	1410	1410	960	630	540	750	1483
TOP						0	0	0	0	0	0	0	0	0					0
MIDL						160	350	180	400	110	290	360	440	260					283.
BOTM						1190	1430	1220	1330	1360	1390	1470	1350	1290					1337
AV						450	593.	467.	577.	490	560	610	597.	517.					540.

(6)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	30	30	0
9	150	180	270	0	30	30	30	0	30	30	60	0	30	0	150	150	210	180	23.3
10	300	300	480	0	90	150	120	0	90	150	120	0	60	120	300	270	330	300	90
11	420	450	600	0	270	420	270	0	210	330	270	30	120	390	510	360	420	360	227.
12	570	510	810	510	660	870	600	480	720	750	660	510	600	690	690	510	510	450	653.
13	660	570	960	930	1200	1320	1140	1140	1140	1170	1050	1230	960	1050	1050	720	540	540	1133
14	810	750	1020	1230	1410	1440	1350	1320	1410	1470	1320	1410	1290	1080	1080	990	600	600	1343
15	960	870	1080	1380	1530	1530	1500	1380	1560	1410	1410	1410	1530	1200	1200	1110	690	720	1437
TOP						10	10	0	10	10	20	0	10	0					7.78
MIDL						480	330	160	340	410	350	180	260	400					323.
BOTM						1430	1330	1280	1370	1350	1260	1350	1260	1110					1304
AV						640	557.	480	573.	590	543.	510	510	503.					545.

(c)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	30	0	0	0	0	0	30	0	0	0	0	0	0	0	3.33
9	60	90	60	0	90	0	60	0	30	0	60	0	30	0	0	30	0	30	20
10	300	150	210	0	180	30	180	0	120	0	150	0	150	0	180	120	150	90	70
11	420	270	390	0	390	300	330	0	330	240	240	0	270	0	300	210	360	210	190
12	660	390	510	60	810	660	630	300	660	540	360	90	510	360	420	510	420	360	457.
13	780	510	630	480	990	990	1020	660	930	870	720	600	780	810	660	720	570	480	820
14	900	630	660	900	1110	1050	1110	900	1110	990	900	930	960	1080	750	810	630	600	1003
15	960	720	750	1050	1140	1080	1170	960	1110	1080	960	1080	990	1080	870	870	690	660	1057
TOP						0	20	0	10	0	30	0	10	0					7.78
MIDL						330	380	100	370	260	250	30	310	120					225.
BOTM						1040	1100	840	1050	980	860	870	910	990					96.
AV						457.	500	313.	477.	413.	380	300	410	370					402.

(P)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	90	120	150	0	0	0	0	30	30	0	0	30	0	0	60	150	30	90	10
10	270	270	300	90	90	0	30	120	90	0	60	60	90	0	150	360	210	270	50
11	420	420	360	300	210	0	120	270	300	0	180	210	210	0	330	480	270	390	143.
12	510	510	420	600	480	300	300	720	660	510	420	480	450	420	570	510	360	480	473.
13	510	600	480	930	930	990	900	1170	1110	1140	1020	930	990	900	870	570	420	570	1017
14	510	660	570	1050	1230	1350	1260	1470	1590	1410	1440	1290	1350	1200	1020	630	480	690	1373
15	510	720	660	1110	1350	1500	1410	1590	1710	1530	1440	1440	1530	1290	1170	630	570	810	1493
TOP						0	0	10	10	0	0	10	0	0					3.33
MIDL						100	150	370	350	170	220	250	250	140					222.
BOTM						1280	1190	1410	1470	1360	1300	1220	1290	1130					1294
AV						460	447.	597.	610	510	507.	493.	513.	423.					507.

(e)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	120	180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0
10	150	240	270	120	0	0	0	0	0	0	0	30	0	0	0	0	150	180	3.33
11	270	300	390	330	30	0	0	240	30	0	30	210	120	0	0	120	300	240	70
12	360	360	450	570	300	180	210	540	300	360	270	480	360	270	150	360	420	330	330
13	420	420	510	810	630	750	600	930	630	870	600	900	750	720	600	570	510	390	750
14	480	510	570	900	960	1020	990	1170	1020	1200	930	1170	1050	990	870	750	630	450	1060
15	570	570	630	960	1140	1260	1170	1440	1260	1260	1200	1350	1260	1080	1020	870	750	510	1253
TOP						0	0	0	0	0	0	0	0	0					0
MIDL						60	70	260	110	120	100	240	160	90					134.
BOTM						1010	920	1180	970	1110	910	1140	1020	930					1021
AV						357.	330	480	360	410	337.	460	393.	340					385.

(F)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	30	90	120	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	3.33
9	180	210	270	60	60	0	30	60	30	0	30	0	30	0	60	180	30	30	20
10	270	330	360	210	120	0	90	120	120	0	120	90	90	0	150	330	210	210	70
11	360	420	390	420	270	0	240	240	240	120	330	150	180	0	300	420	300	300	167.
12	420	450	450	540	420	120	450	420	480	360	600	360	360	0	480	450	300	300	350
13	480	510	510	690	810	480	780	780	780	720	990	540	630	210	570	480	420	420	657.
14	540	510	510	780	1020	990	1050	1050	1080	1080	1230	900	990	570	720	570	450	450	993.
15	570	570	570	810	1110	1200	1260	1320	1320	1380	1380	1230	1230	840	780	600	540	540	1240
TOP						0	10	30	10	0	10	0	10	0					7.78
MIDL						40	260	260	280	160	350	200	210	0					196.
BOTM						890	1030	1050	1060	1060	1200	890	950	540					963.
AV						310	433.	447.	450	407.	520	363.	390	180					389.

(9)

DEPTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AVE
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	30	30	60	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0
9	150	150	240	60	30	0	30	30	30	0	30	30	30	0	60	150	0	0	20
10	300	270	360	210	90	0	90	90	90	0	90	60	90	0	90	330	210	240	56.7
11	450	390	450	360	120	30	150	150	180	90	180	120	180	0	240	450	330	330	120
12	600	510	540	540	240	150	270	270	270	210	300	210	300	30	420	600	420	480	223.
13	690	630	660	660	480	420	480	570	480	420	600	390	540	240	570	720	570	570	460
14	750	720	780	720	720	810	810	900	780	810	990	690	810	600	720	780	690	690	800
15	780	720	780	780	870	1140	1050	1200	1170	1230	1350	1050	1140	900	840	900	780	750	1137
TOP						0	10	10	10	0	10	10	10	0					6.67
MIDL						60	170	170	[illegible]	100	190	[illegible]	190	[illegible]					[illegible]
BOTM						790	780	890	[illegible]	820	980	[illegible]	830	580					795.
AV						283.	320	357.	[illegible]	307.	293.	283.	343.	197.					313.