Identification Of The Relationship Between Shoe Wear And Hoof Capsule Distortion In The Shod Front Foot.

Farrier Staff Sergeant Neil Madden RAVC.

Acknowledgements

I would like to thank the Commandant of the Defence Animal Centre Colonel D. A. Macdonald BVMS. MSc. MRCVS. and the Commanding Officer, The Kings Troop Royal Horse Artillery Major W. J.G Connell for the use of the horses, materials and facilities which were made available to carry out the study.

A word of thanks is also extended to those people who helped in the practical testing of the thesis.

A special thanks is made to I. T. Bell FWCF Hon's. MBE for his help and direction as a mentor and to the Farriers at the Army School of Farriery for all their help.

Contents

" SHOE WEAR CAN BE RELATED TO WEIGHT BEARING WHILE THE FOOT IS ON THE GROUND OR TO DRAGGING OF THE SHOE AS THE FOOT LANDS OR LEAVES THE GROUND"

(Hickmans Farriery 2nd Edition)

SUMMARY

This study set out to establish clear definition for shoe wear patterns and their relationship to conformation defects and hoof capsule distortion. Two separate control groups with similar conformation but different work regimes were studied over a 12-month period and all horses re-shod in a 3-5-week cycle. All relevant data were recorded and analysed.

The study clearly shows the relationship between conformation and hoof capsule distortion, as well as categorising shoe wear patterns to the ground reaction force (GRF) associated with specific conformation defects.

It further indicates the necessity to account for all aspects of conformation, hoof capsule distortion and shoe wear prior to the selection and application of any trimming and shoeing protocol in addition to highlighting the short comings of recent trimming guidelines that have been advocated as rigid rules that clearly cannot be applied to many individual conformation types. •

• References made in this study are referred to the Bibliography

Identification Of The Relationship Between Shoe Wear And Hoof Capsule Distortion In The Shod Front Foot

INTRODUCTION

The need to protect the horse's foot from the forces to which it has been exposed has been well documented through time. History shows many examples. Hickman's Farriery quotes The Greek General Xenophon (430-354BC), " If he has not good feet there is no profit in him as a war horse."

A.W Dollar and A Wheatly's Handbook of Horseshoeing tells of writings about Mithridates, King of Pontus (First Century BC), " while laying siege to Cycicus, sent his entire cavalry to Bithynia for treatment on account of the manner in which the horse feet had suffered from prolonged marches."

The hoof capsule has evolved to protect the sensitive underlying structures of the foot. It provides a basal support for weight bearing and has a bio-mechanical function that helps dissipate concussion and promote grip during locomotion.

Through domestication it has been found that the functional limits of the hoof capsule can be easily exceeded causing the horse to become lame. The most important function of shoeing is to protect the foot from wear and tear from modern surfaces.

The Farrier assesses shoe wear and hoof capsule distortion when dressing and balancing the foot for the application of a shoe in order to promote even weight bearing across the sectional area of the foot. This study set out to establish the forces that most affect the shod front foot by identifying the causes of shoe wear and hoof capsule distortion and to classify this in relation to conformation types.

Friction wear of the shoe is created by the resistance generated, on contact, between the shoe and ground in the horizontal axis during locomotion. Where as Hoof capsule distortion is influenced by force loading the foot in the vertical axis.

During locomotion the horse's body mass is in constant motion but the foot must be static to bear weight fully. The junction between dynamic movement and static support defines the boundaries between shoe wear and hoof capsule distortion.

Terms Of Reference

The aim of this paper is to identify the relationship between friction wear of the ground bearing surface of the shoe in the horizontal axis and hoof capsule distortion as a result of ground reaction force in the vertical axis in the shod front foot.

Theoretic Considerations

With the application of basic mechanics and Newton's laws of motions (annex A), the comparison of results of ground reaction force studies in the vertical axis (hoof capsule distortion) with results of ground reaction force in the horizontal axis (shoe wear) should make it possible to identify the relationship between both forces.

Bio-mechanics deals with the Statics and Dynamics of a living organism which are subjects that form the basis for understanding the action of forces, the nature of movement and the way in which these phenomena interrelate with each other.

Farriers deal directly with these subjects, perhaps unknowingly, on a day to day basis when shoeing horses. To understand how force affects a stationary structure it is necessary to study a free body diagram (Fig 1); an imaginary diagram hung freely in space. By applying obvious forces that affect it we realise that the only force that is encountered is gravity.

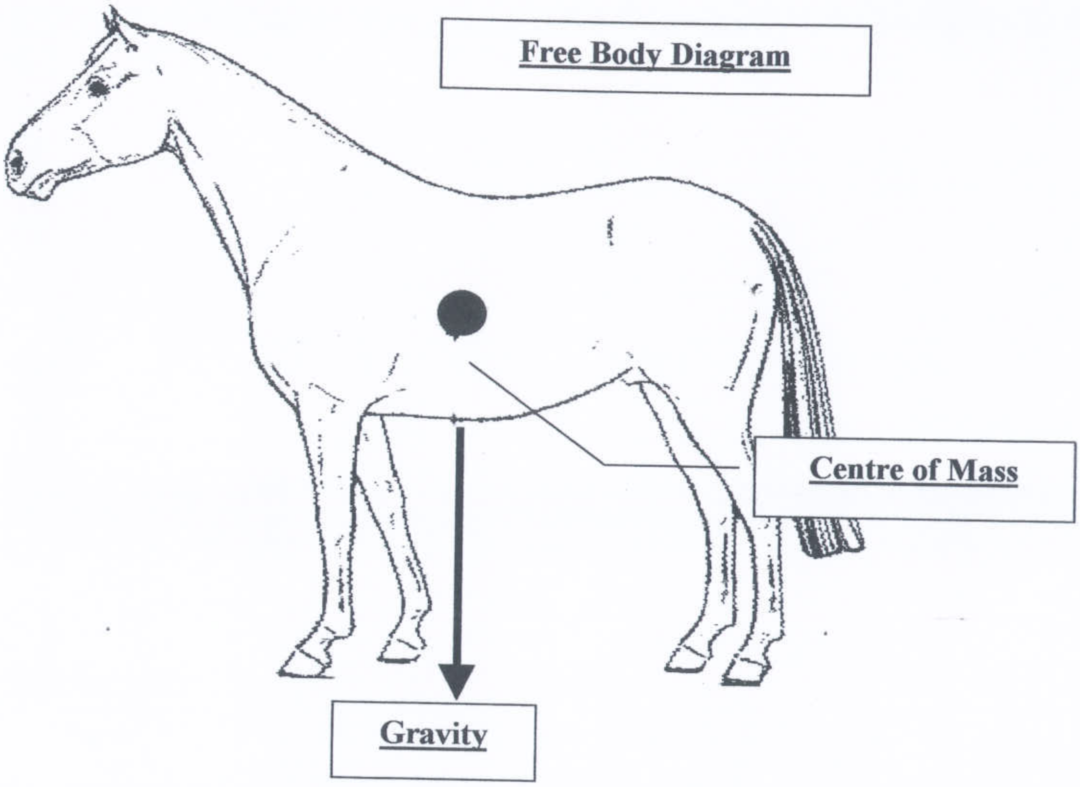
Terms and definitions relating to mechanics that were adopted for this study were:

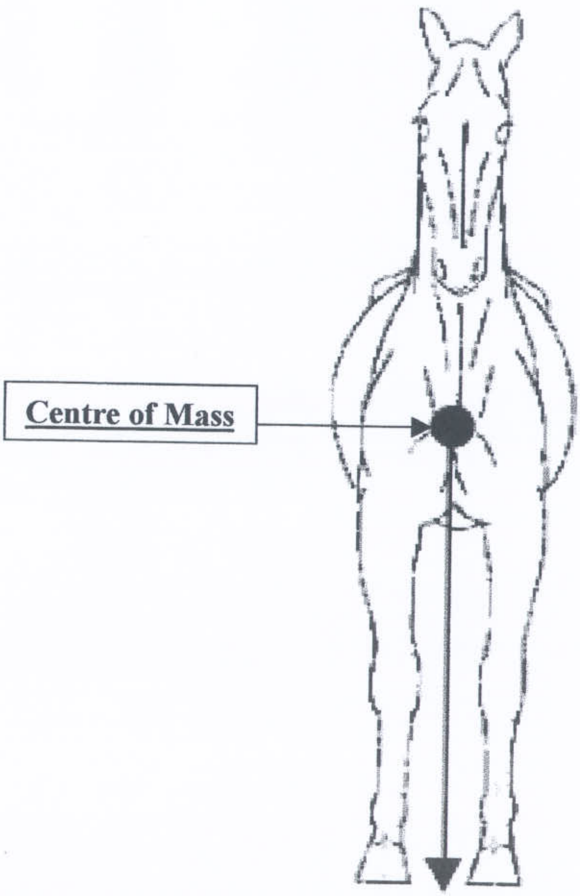
Static's The study of the behavior of forces acting on an object at rest. For the Farrier this relates to conformation assessment, hoof capsule distortion and foot balance.

Dynamics The study of motion and the forces that cause it. This is subdivided into kinetics and kinematics

Kinetics The study of motion in relation to the forces causing it. Its relation to farriery includes muscle function and symmetry of the horse, gait assessment, foot flight and foot fall, lameness identification, foot displacement, foot impact and loading, shoe wear, hoof capsule distortion and break over.

Fig1





NB. Free body diagram showing the influence of gravity.

Kinematics The study of motion itself. This is related to the overall movement and co-ordination of the horse. Gait assessment, Lameness identification, kinematic break over, foot flight and footfall.

Gravity

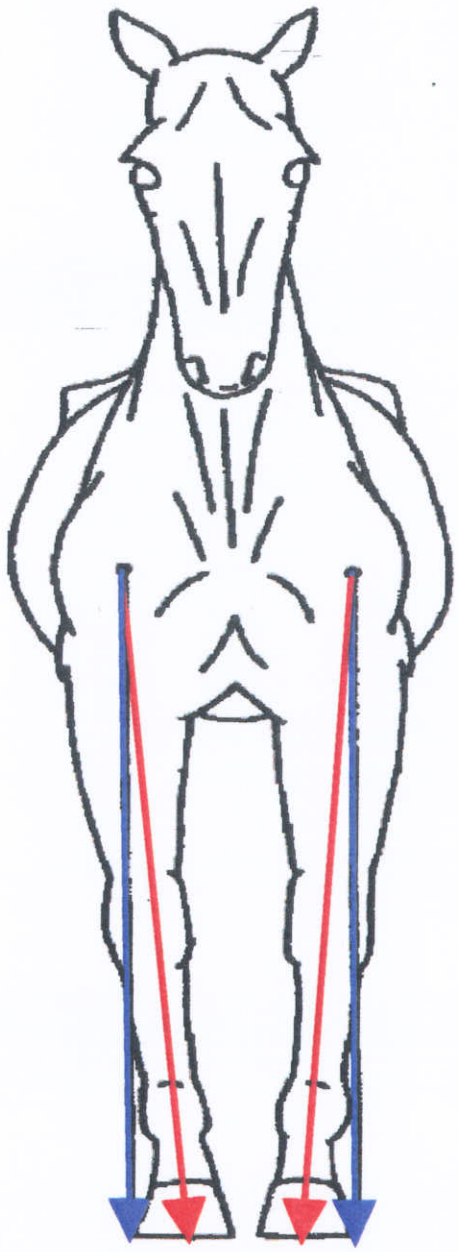
Gravity is a *remote force* and the horse does not have to be in contact with the ground to be affected by it, therefore gravity is constantly acting on the horse's mass; in accordance with Newton's first law of motion (annex A).

The weight of a body is the force generated through its mass, (a measure of the number of atoms that make up the body,) being attracted to the centre of the earth by the earth's gravitational pull. It is important to note that weight has magnitude and direction and is classed as a *direct force*.

Two axes of force can be identified (Fig 2) the *remote force* "Gravity" the pull of the earth on the centre of the horses body mass and *direct force* "Weight", the force generated by the pull of gravity.

The axis of gravity is always perpendicular to the centre of the earth. The axis of weight, in relation to the foot, is determined by the conformation of the horse's limb by virtue of direct bone to bone contact.

Fig 2



Key

Direct force (Weight)
Remote force (Gravity)

NB. The axis of gravity and axis of weight by virtue of bone to bone contact are clearly different in poorly conformed horses.

Good conformation allows the geometric axis of the limbs to be closely aligned to the vertical axis of gravity. When poor conformation prevails it is easy to see the conflict in the line of axis for both forces and the difference in opinions of individual Farriers in terms of dressing the foot to achieve even load bearing for shoeing.

The distribution of the remote force of gravity and the direct force of weight on the bearing surface of the foot are governed by the centre of gravity of the horse's body, in relation to the placement of the horse's foot.

The ideal conformation specifies that the centre of geometric axis of the bones in the limb aligns with the vertical axis of gravity. The combination of co-linear forces on the same axis acting on the centre of the bearing surface of a symmetrical foot would ensure even distribution of force over the cross section of the foot; allowing the foot to function as effectively as possible.

Poor conformation both, congenital and acquired, causes asymmetric loading of the hoof capsule leading to distortion (Lungwitz). The distortion is created by compressive stress exceeding the strain capabilities of the hoof horn structures, which are influenced by turning moments.

The free body diagram allows for the identification of forces in the vertical axis and the likely friction wear of the shoe is created in the horizontal axis.

Friction is the resistance between two sliding surfaces. The forces concerned are always equal in magnitude and opposite in direction, in accordance with Newton's

Third Law of Motion (annex A), and the amount of friction is relative to the co-efficient of friction; the roughness of the surfaces coming into contact.

Friction is a mechanism that allows for the dissipation of energy and can be either a positive or a negative force. Friction is positive when it assists starting, maintaining and stopping locomotion. It is negative when it generates concussive forces, for example rubber shoes used on a metalled road. These have been proven (Pardoe, Wilson et al) to restrict the natural sliding motion of the foot and the foot comes to a sudden halt on impact, the force that would normally be absorbed by a metal shoe sliding on impact is now absorbed by the anatomical structures of the foot and limb. The result of this kind of negative friction is seen in concussive injuries i.e. Side bone, Ringbone and Navicular syndrome.

Friction is encountered not only during motion but also when the horse is static. If there was no friction between the surface on which the horse is standing and the shoe then the horse would slip as though it is on ice.

During trot measurements of longitudinal and vertical ground reaction force of the support phase of the front limb found that the foot became static within the first 10 % of the stance phase but was not fully loaded until between 40% and 50% of the phase (Clayton et al).

It is reasonable to assume that friction wear takes place on impact, when the foot contacts the ground, up to the point where the reaction force from the ground is of equal resistance to the action force of the foot bringing it to a halt and beginning the static phase of the stride.

MATERIALS AND METHODS

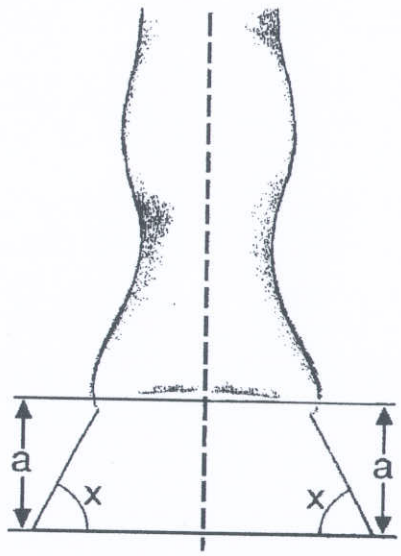
Two study groups of fifteen (Group1) and thirty-five (Group 2) military horses of the same breed and good conformation were used to relate conformation and hoof capsule distortion to specific shoe wear patterns (annex B). The groups were classified according to work, breed and conformation. The type of work was ride and drive for group 1 and riding school for group 2. Both groups were sub divided into specific lower limb conformation types within an acceptable tolerance band i.e. Vertical rotated axis, Fetlock Valgus, Fetlock Varus, Toe in ,Toe out, Base wide and Base Narrow. Group 1 was further subdivided into the position of each horse within the gun team: Lead, Centre and Wheeler.

The horses were individually assessed for lameness and any serious limb deformities. Lame horses and horses with serious limb deformities, which did not fit selection criteria, were not used in the study.

The feet were dressed in accordance with current accepted practice. Medial Lateral Balance was achieved by ensuring that the centre line of the long axis bisected the ground bearing surface of the foot, ensuring equal amounts of foot bearing surface either side of the centre line and with the bearing surface perpendicular to the long axis. Observations were made of the length of the medial and lateral wall to ensure that they were the same length and that the coronary band, although a flexible structure was parallel to the ground bearing surface when viewed from the dorsal aspect during weight bearing. A shunted coronary band is often the sign of asymmetric or point loading of the hoof.

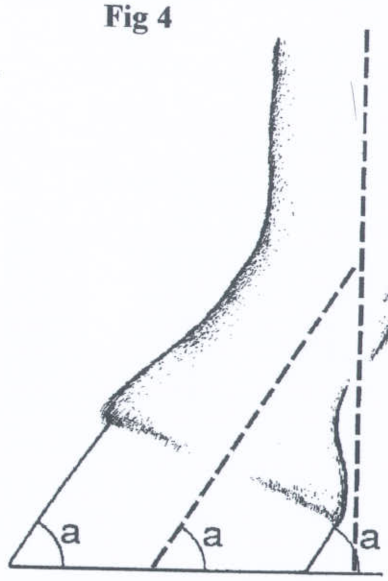
The hoof pastern axis (HPA) was assessed ensuring that the hoof and pastern were aligned and the HPA bisected the foot-bearing surface into two equal halves (Fig 4). The HPA was also observed from the front by ensuring mediolateral balance (Fig 3).

Fig 3



HPA Dorsal View

Fig 4



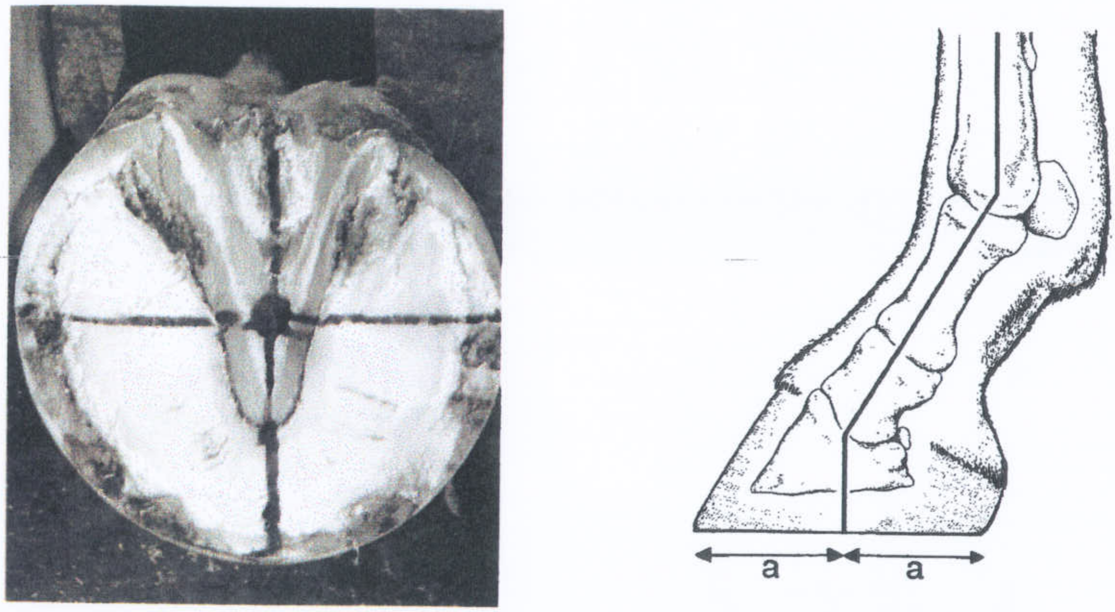
HPA Lateral View

Symmetry of the solar surface was assessed by applying a theoretical line bisecting the foot into two equal halves the purpose to ensure that the right half of the solar surface was a mirror image of the left side and vice versa.

The centre of the bearing surface of the foot was decided on as central reference point for both trimming and shoe application. It was defined by measuring the solar surface for length, to the end of the heel, and the width at the widest part of the foot.

It was found that on average the centre of the medial lateral measurement was the centre line of the frog and the lines bisected each other approximately one and a quarter inches from the true point of frog (Plate 1).

Plate 1



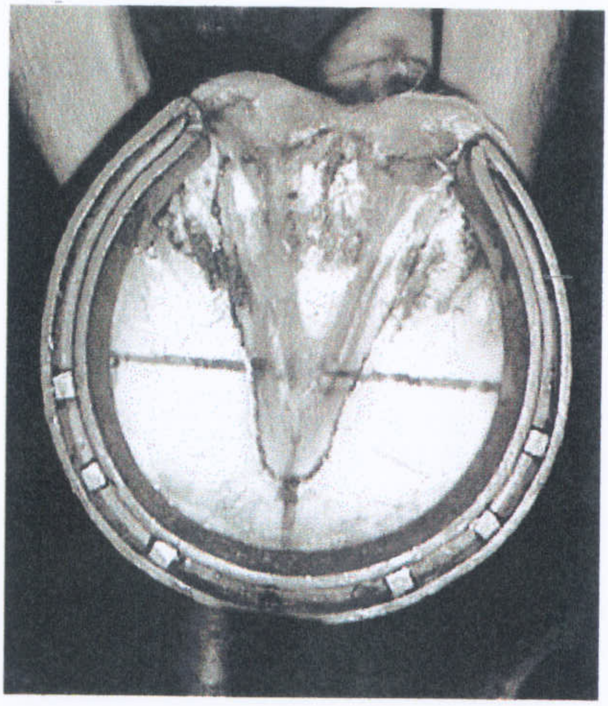
Centre of the bearing surface of the foot

Two types of shoes were applied for both groups; ready-made fullered concave and hand made three-quarter fullered from flat bar. The size and section of the material was selected according to the size of foot and type of work being done.

Group 1, because of the nature of work for horses working in a team, shoes were fitted to promote an outline fit, with the heels on the front shoes fitted with between an eighth and sixteenth of an inch length past the end of the heel. The front shoes were welded at the toe with hard facing weld, BS 8963: E 8555. During ceremonial parades screw in studs were also used one in each branch of the front and hind shoes to enhance grip; reducing friction wear.

Group 2 shoes were fitted to the foot with the centre of the section of metal following the white line with heels of the same length bearing in mind the safety requirements for fast working horses.

Plate 2



Shoe fit symmetrically to the foot (Group2)

The feet were dressed as symmetrically as possible in relation to the conformation leading to the application of a shoe (Plate 2). This meant that it was not always possible to fit a symmetrical shoe as some of the horses within the target group had a toe in conformation with a straighter out side toe quarter in the area of the break over. Because of the alignment of the foot and knee fitting a symmetrical shoe in these cases would have created greater stresses in order to achieve kinetic break over.

When the subject horses feet were balanced and shod a record of the horses name, army number and lower limb conformation was entered onto the shoe wear performer, a form based on a clock ray method one for left feet and one for right feet. (annex C).

The date of shoeing was recorded in the Army Book 71(AB71) (annex D). At an interval on average of four weeks, when the horses were due to be re-shod, hoof capsule distortion and shoe wear was assessed and recorded on the same form as the conformation.

RESULTS

The purpose of the study was to identify the relationship between friction wear of the ground bearing surface of the shoe in the horizontal axis and hoof capsule distortion as a result of ground reaction force in the vertical axis.

Hoof capsule distortion was determined by assessing the feet for balance and identifying where excess horn needed to be removed to balance the foot in accordance with modern shoeing methods. This accounted for mediolateral and caudocrainail imbalance as well as flares created by growth and compression.

Hoof capsule distortion was categorised as follows:

Excess Toe

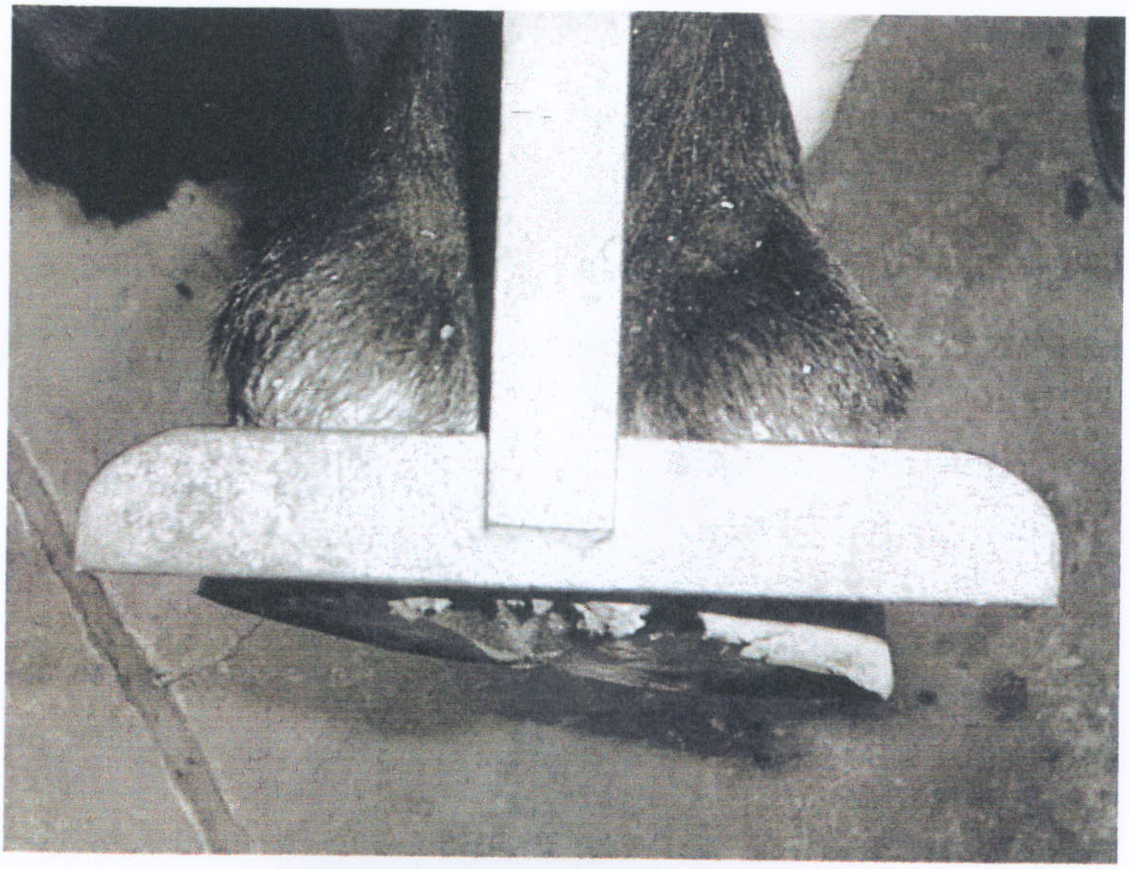
Excess Toe to Outside Heel (Plate 3)

Excess Toe to inside heel

Excess Heels

Even.

Plate 3 Excess toe to lateral branch

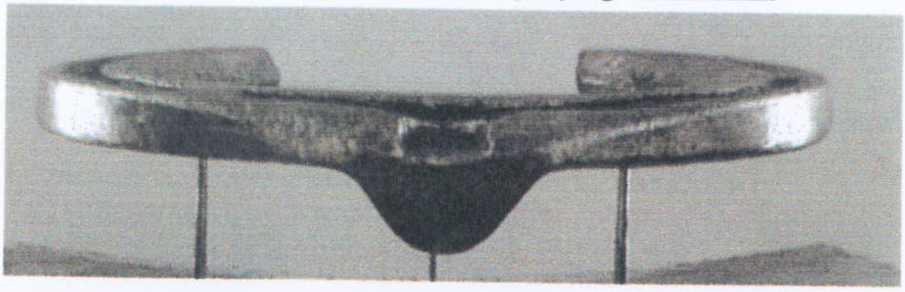


Shoe wear was assessed by the areas that the shoes had been worn most by friction wear. Vices such as the horse pawing the ground and weaving when boxed were aspects that had to be considered when assessing wear patterns.

The results produced six specific areas of wear they were categorised into the following groups:

"Toe Wear" was defined as wear at the toe area (fig 5) due to the break over of the foot and has been divided in to two sub sections. Wear at the "Toe" (Plate 4) and off centre wear at around the position of "Lateral Toe" (Plate 5).

Plate 4 Shoe wear Central Toe accompanying Even Wear



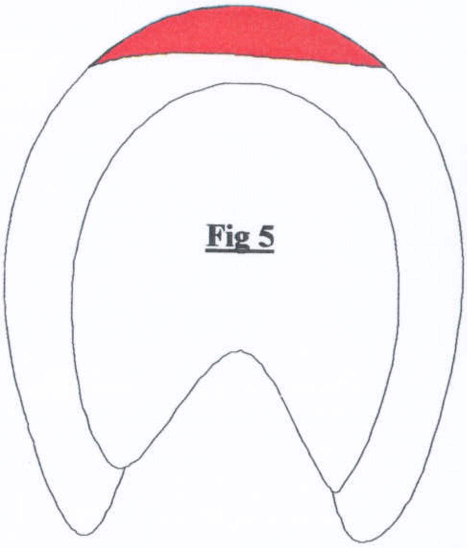


Fig 5

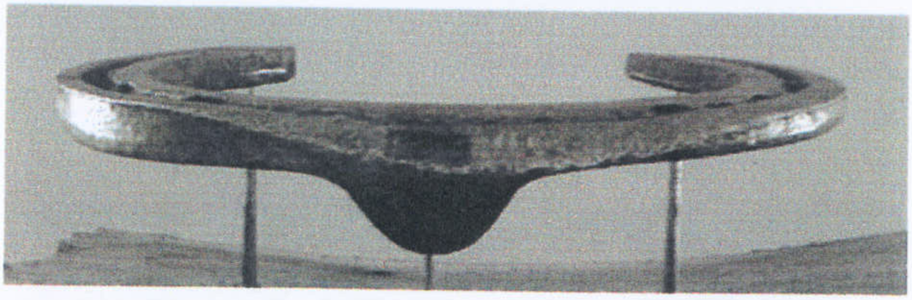


Plate 5 Shoe wear Lateral Toe accompanying Lateral Branch wear

"Even Wear" (Plate 6) was defined as even frictional wear across the whole of the ground-bearing surface of the shoe.

Plate 6 Even Wear

"Lateral Branch Wear" (Fig 7) was classed as greater impact wear from the medial toe area to the lateral heel, developing a mediolateral imbalance (Plate 7).

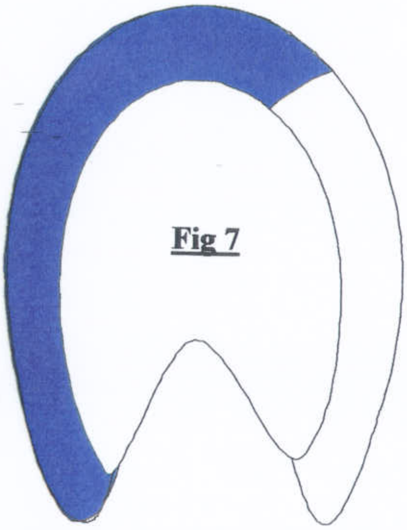
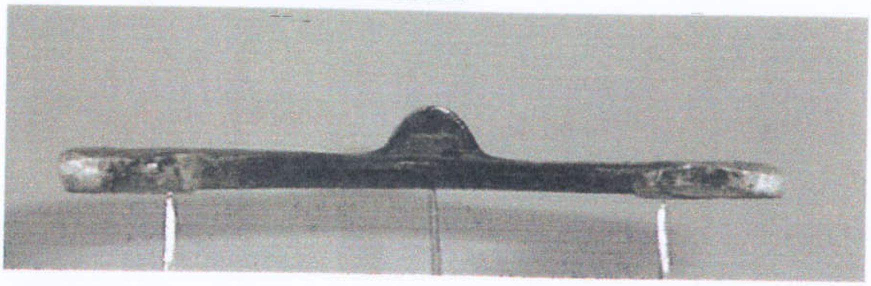


Fig 7

Plate 7 Shoe Wear Lateral Branch



"Cranial Half Wear" (Fig 8) was defined as the front half of the shoe being worn greater than the back half developing a caudocranial imbalance (Plate 8).

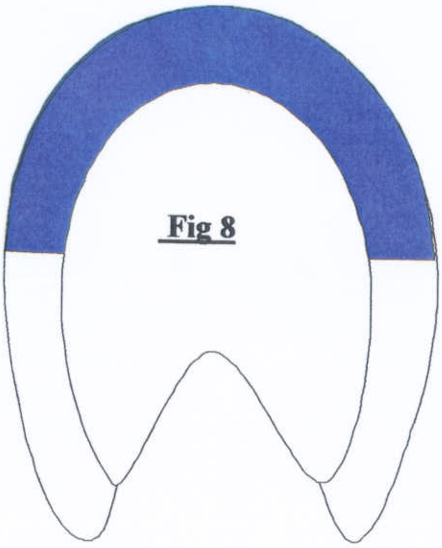
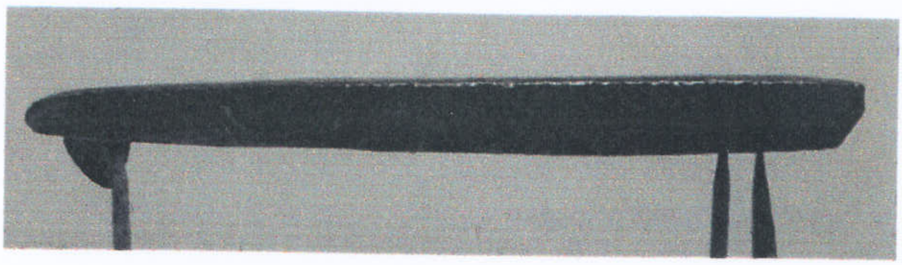


Fig 8

Plate 8 Shoe wear Cranial Half Wear



"Descending Lateral Heel Wear" (fig 6) was defined as wear crated when the foot comes in to land at the end of the stride. This is predominantly seen on the extremities of the lateral heel of the shoe (Plate 9), it is at a different angle from the wear of the ground-bearing surface and indicates impact wear of the shoe before the ground bearing surface meets the ground.

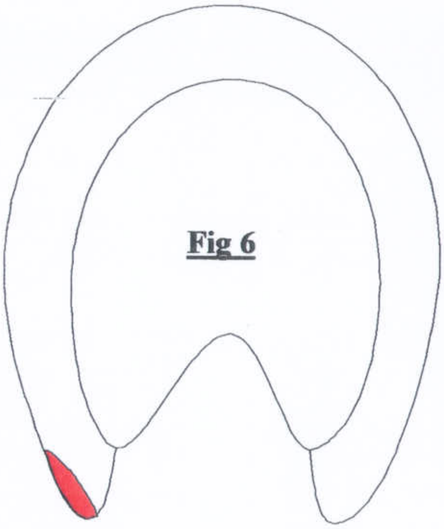
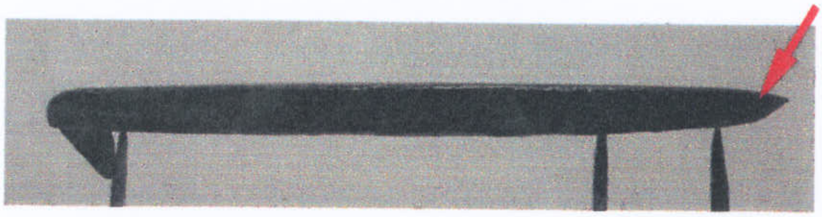


Plate 9 Shoe Wear Lateral Heel Extremity



Three patterns of wear were directly associated with the ground bearing surface of the shoe. They were; Even wear, Lateral Branch Wear and Cranial Half Wear. The three remaining patterns identified were associated with the wear at the centre or lateral aspect of the toe and the extremity of the lateral heel.

Because these types of wear were at a separate angle to the ground bearing surface it was considered they were associated with the foot landing and taking off and would have little effect from vertical loading of the foot.

Results showed that every shoe assessed had Toe friction wear in combination with either Even, Lateral branch or Cranial half wear; heel impact wear was found on 8% of shoes. There was no record of excess medial branch or medial heel wear in either groups.

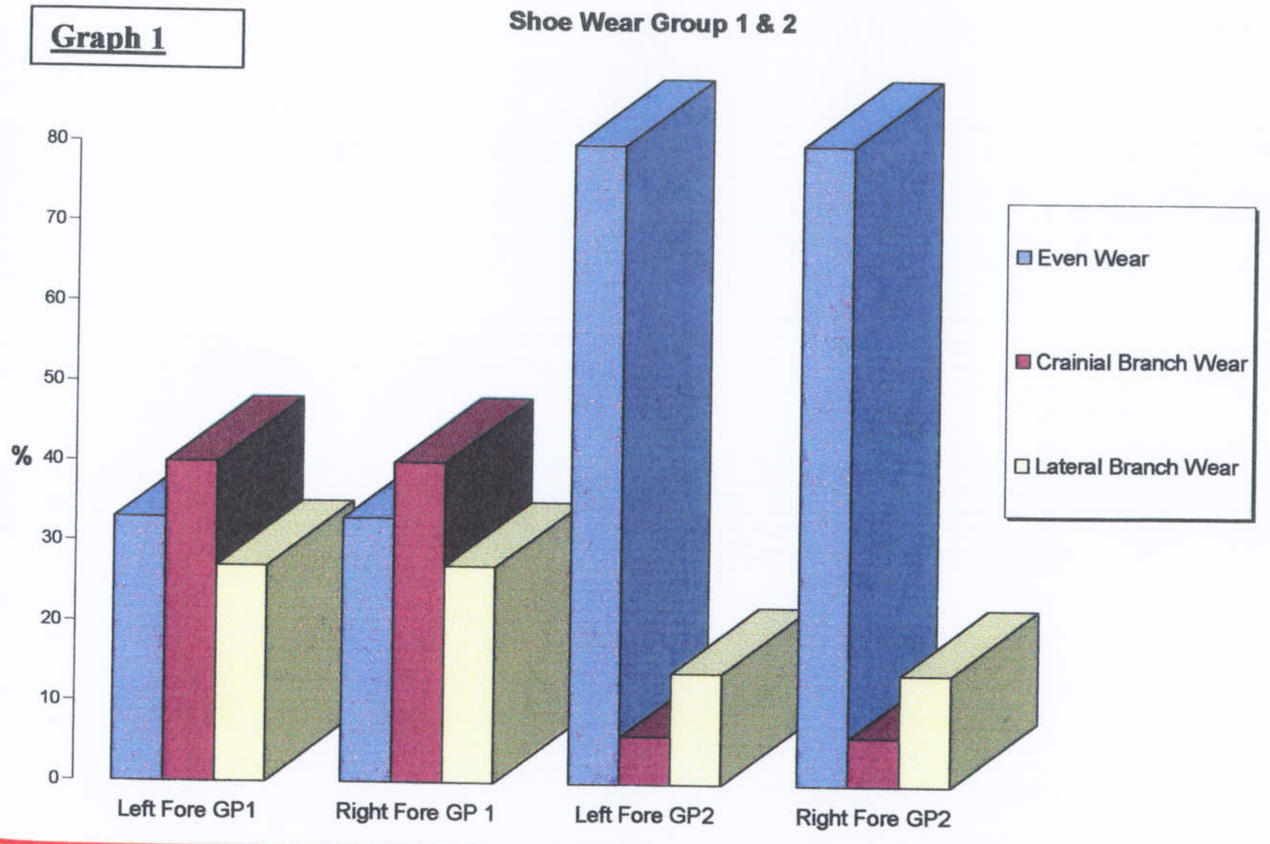
Shoe wear results showed out of 100 individual shoe wear patterns (both groups combined), 66% had Even Wear, 18% Lateral Branch Wear and 16% Cranial Half Wear.

A comparison of shoe wear between Group 1(Ride and Drive) and Group 2(Riding School) (Graph 1) showed a difference in the percentage of wear patterns between the groups.

The highest proportion of shoe wear for each group was:

Group 1 "Cranial Half Wear"	40%
Group 2 "Even Wear"	80%

Graph 1



NB. Graph 1 The comparison of shoe wear patterns between Group 1 and 2

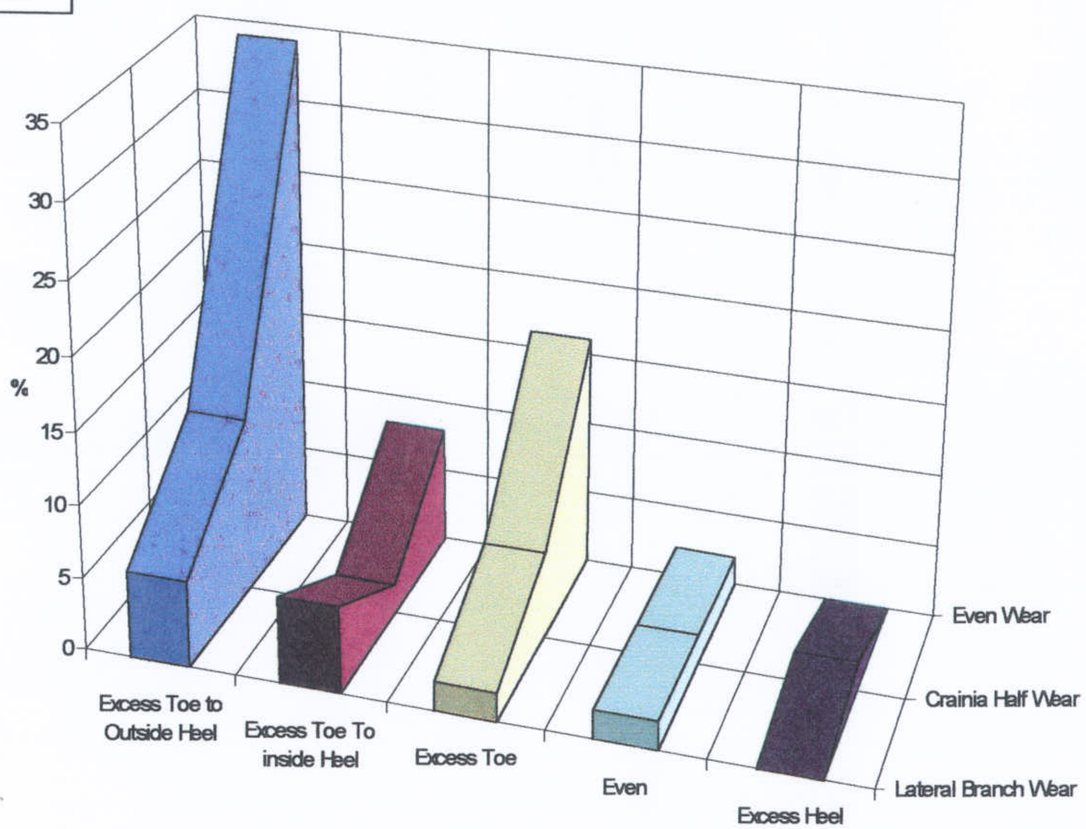
The major cause identified for the difference in percentages was thought to be the type of work (Table 1 , annex B), and the difference in the axis of force generated due to the position of the centre of mass for each specific type of work .

It was not possible to identify shoe wear patterns in relation to gun team positions for group 1 because horses in this group are used as multi position horses.

The assessment of hoof capsule distortion was made by recording the area of the foot that was high and needed to be trimmed to balance it in accordance with textbook descriptions.

Graph 2

Hoof Capsule Distortion and Shoe Wear



NB. Graph 2 The Comparison Between Shoe Wear and Hoof Capsule Distortion

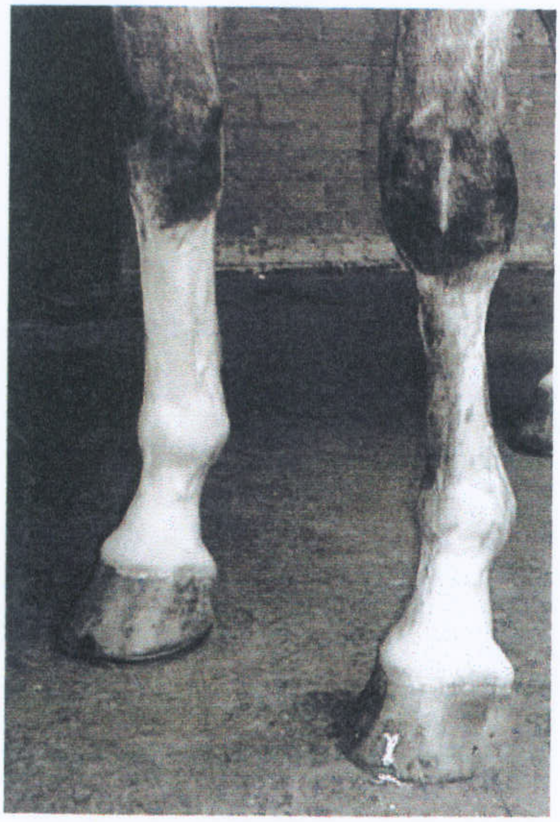
Although the greatest percentage of shoe wear was Even Wear there was only 6% of the combined study groups that required an even amount of horn removal across the bearing surface of the foot to balance it. The most common type of hoof capsule distortion was found to be "Excess Toe to Outside Heel". This was recorded at 52% of the combined groups.

Hoof capsule distortion was found to be a reflection of the conformation of the limb. Horses with deviations to towards the midline of the body i.e. Toe in, Base narrow and Fetlock Varus had hoof capsule distortion that reflected force passing down the outside of the limb, horses with limb deviation away from the midline of the body had hoof capsule distortion reflecting more medial weight bearing.

Plate 10

Fetlock Varus creating a medial flare.

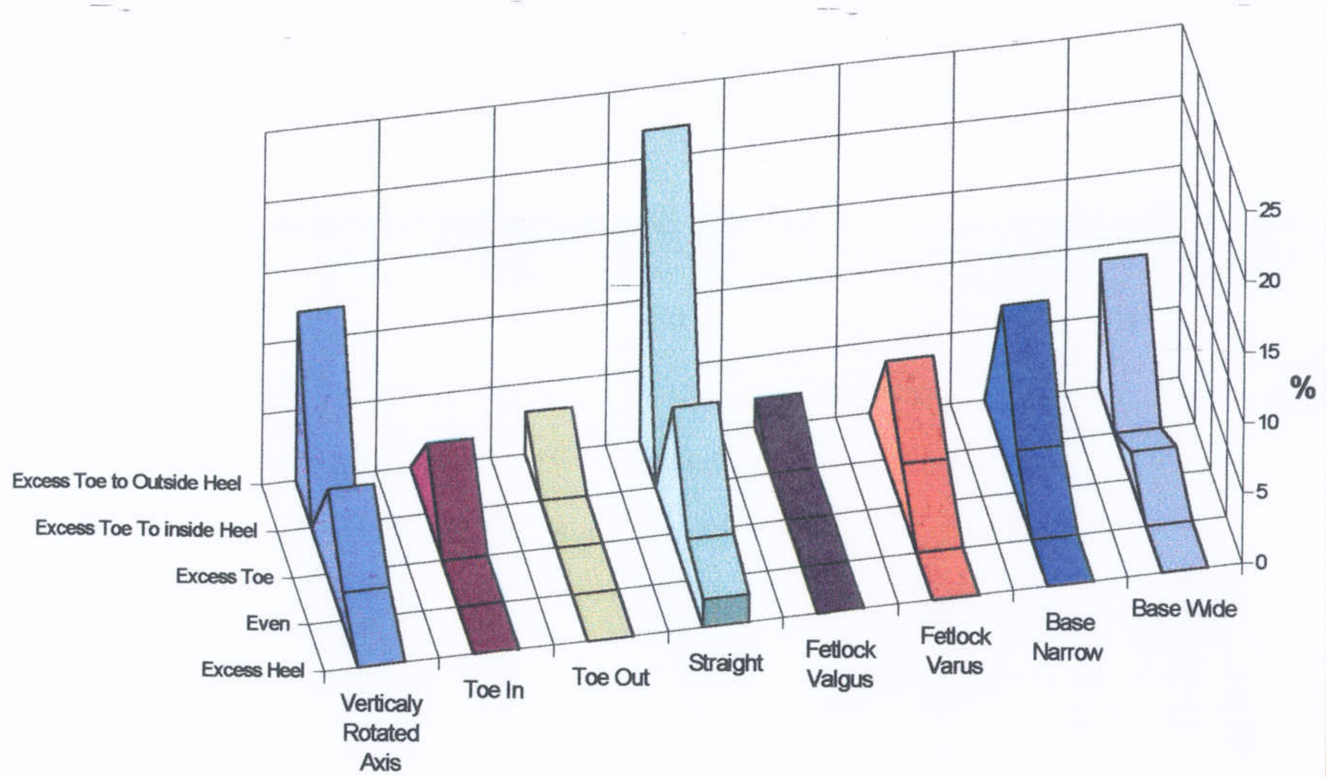
Plate 11



Vertically rotated axis

It was also noted while conformation is a major influence on hoof capsule distortion it is not always reflected in the shoe wear.

Graph 3



Graph 3 The Comparison of conformation and hoof capsule distortion.

DISCUSSION

It is common practice for Farriers to assess shoe wear in relation to hoof capsule distortion when balancing the foot. The reason for this is to encourage even cross sectional loading of the foot. Modern farriery literature highlights the necessity for assessing shoe wear patterns. Shoe wear is an indication of weight bearing while the foot is on the ground, foot balance and conformation. (Hicmans 2nd Edition).

The results of this study showed that the biggest combined proportion, 52%, of hoof capsule distortion recorded was Excess Toe to Lateral Heel. It was expected that this type of distortion would be reflected in shoe wear by the excess wearing of the outside branch of the shoe. This was not the case, both groups combined only 16% of shoe wear was categorised as Lateral Branch Wear.

During locomotion the horses' body is in constant motion, the foot must be static to support the weight of the horses' body as it passes over it. The acceleration of the foot during locomotion is proportional to the force acting on it. When the foot contacts the ground it is met by a ground reaction force (GRF) equal in magnitude and opposite in direction. This can be interpreted as "Impact Force". If the foot impacts unevenly the shoe will wear greater at the impact area. The interval between the foot impacting the ground and coming to rest has been termed as the "Slip Interval" (Pardoe et al).
During the slip interval the foot will begin to load causing friction wear to the whole of the surface of the shoe in contact with the ground.

Factors that can influence even or uneven impact are asymmetric section on the shoe, studs and plugs, mordax nails, foot dressing, faulty action (i.e. chopping in) and conformation.

Friction wear of the shoe takes place in the horizontal axis, hoof capsule distortion is in the vertical axis. The junction between dynamic movement and static support defines the boundaries between shoe wear and hoof capsule distortion.

The greatest influence on hoof capsule distortion is the position of the centre of mass of the horses' body in relation to foot placement. The horse is a dynamic animal constantly changing foot placement to compensate for the change in direction and position of the centre of mass during locomotion.

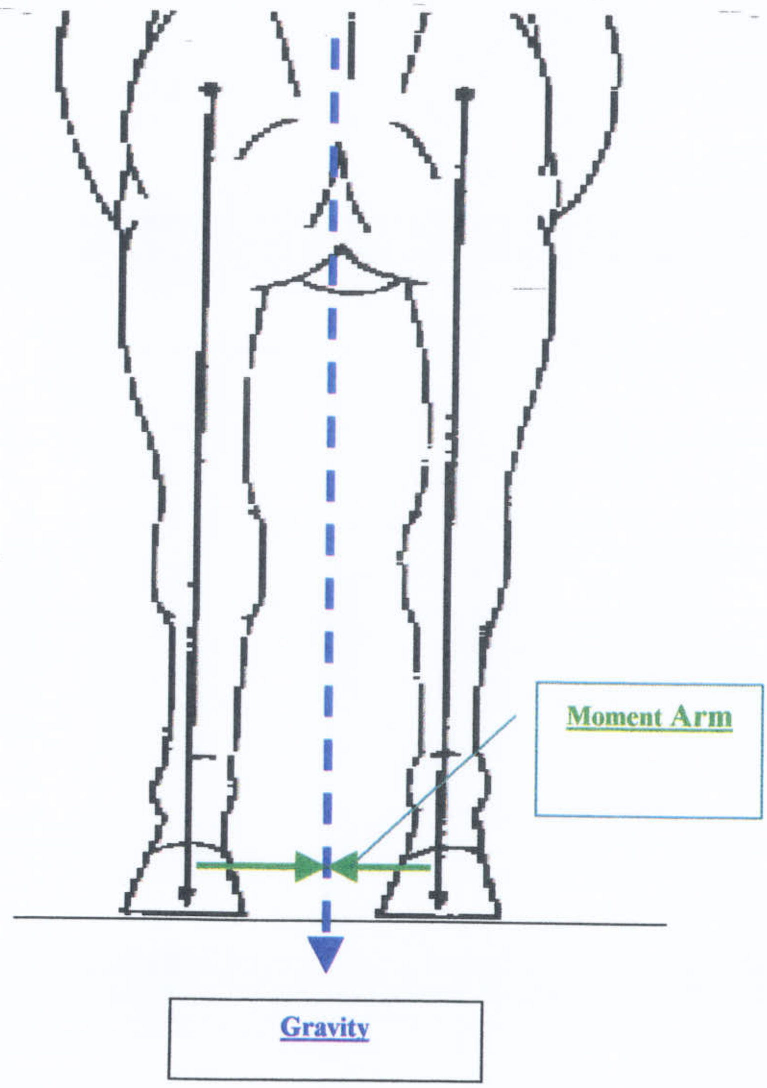
To determine how forces in the vertical axis affect the hoof capsule and shoe theoretical consideration of turning moments must be understood.

Turning Force and Moments

Weight is transmitted, by direct contact, through the columns of bones to the hoof capsule in contact with the floor. The foot, static at this point, is in a state of equilibrium. It is important to remember that gravity is constantly acting on the mass of the horse. When two forces on the same axis act on two different areas of a body they cause rotation. A centre line dropped from the centre of mass to the floor (Fig9), *representing the axis on which the remote force of gravity acts* will be between the front limbs. A line, perpendicular to this centre line, is drawn from the centre of rotation of the hoof. This now defines the ***moment arm*** or turning force that is created by the co linear axis of remote and direct forces.

The longer the ***moment arm*** the greater the turning force becomes.

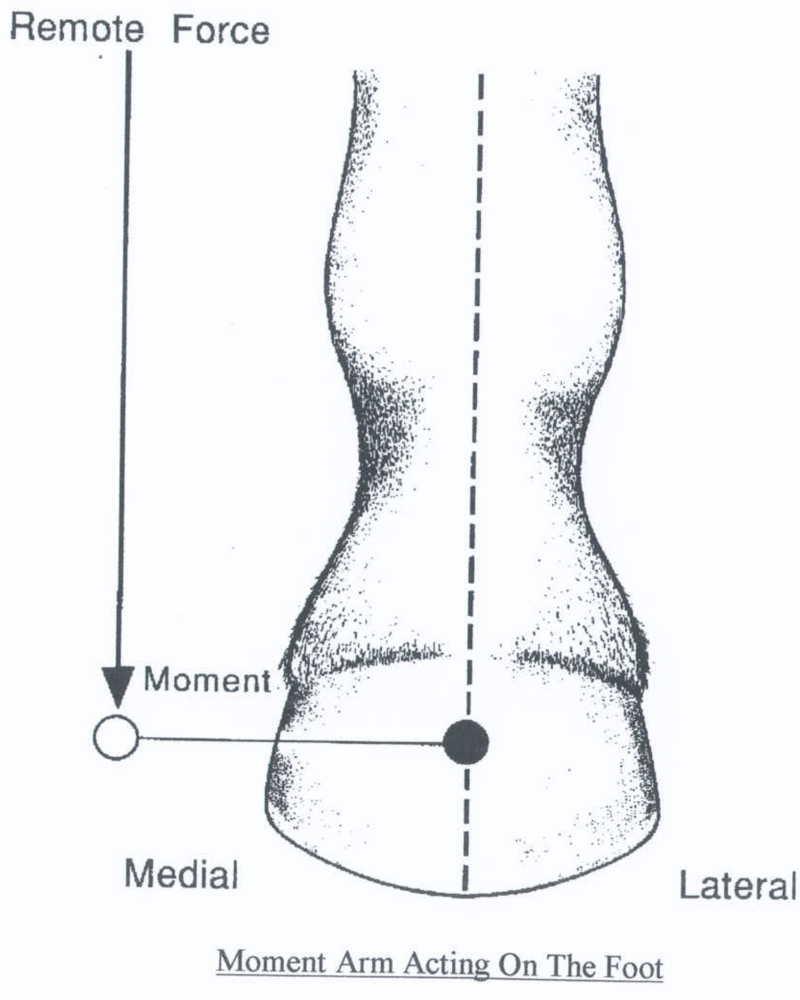
Fig 9



The horse is a three-dimensional body occupying real space and the combination of the moment's mediolateral and caudocranial will result in the action of the resultant forces affecting the medial heel. Because of the to the position of the centre of mass in relation to the centre of the foot, asymmetric loading of the hoof capsule places more force on the medial side and medial heel area of the front foot when at rest. (Colahan et al 1993)

The vertical force that acts on the axis of the bone, direct force, is spread over the bearing surface of the foot. Mechanically a structure will function at its best when weight is born evenly over its cross sectional area, this is the reason why the foot should be a symmetrical shape concentric to the axis of vertical force.

Fig 10

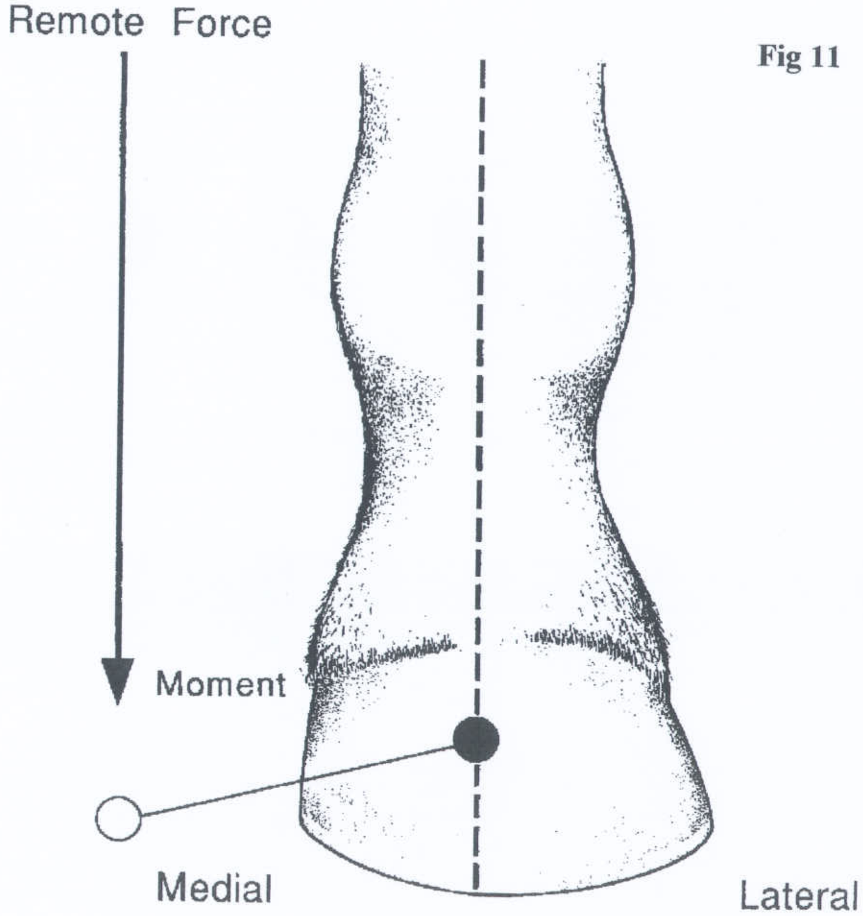


Moment Arm Acting On The Foot

The influence of the remote force of gravity acting on the centre of mass of the horse creates a turning moment that develops between the centre of the foot and axis of remote force which influences hoof capsule to distort.

The combination of weight, as an action force, and the opposite reaction force from the ground causes the soft tissue structures directly between the descending weight of the body and resistance of the ground to become compressed. Even though the forces are in equilibrium distortion through compression, however small, still takes place.

Fig 11



Turning force effecting the foot creating medial compression and lateral flareing

In practice, the lateral wall in the above case (Fig 11) of hoof distortion is longer than the medial wall but due to compressive stress exceeding the limits of the strain capability of the horn, the wall begins to dish and flare. The foot is asymmetrically loaded towards the medial aspect.

Hoof capsule Distortion "Excess Toe to Outside Heel" characteristically had a lower or compressed inside wall and or medial heel. This type of distortion was a reflection of Colahans' findings.

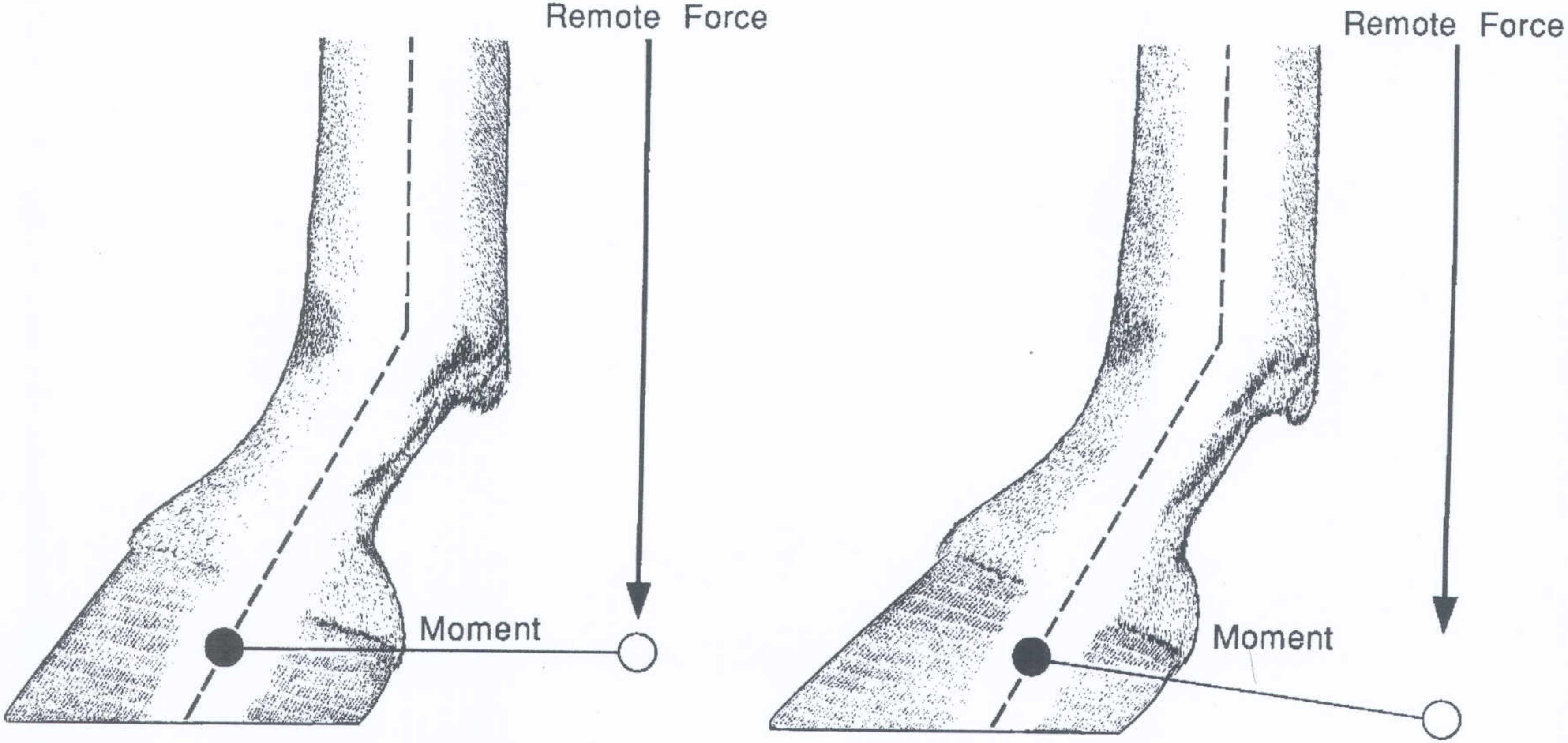
76% of all recorded hoof capsule distortion had an excess of toe, this influenced more pressure being placed on the heels.

Gravity acting on the centre of mass compounds increased pressure on the heel, the result is crushed heels and a long toe. Viewed from the lateral aspect the axis of remote force from the centre of mass is behind the centre axis of the front limbs. The turning moment that acts on the hoof capsule on this plane causes the heels to be crushed and the toe to become longer. The centre point of the bearing surface of the foot moves forwards causing greater weight bearing on the palmer aspect of the foot (Fig 12).

The hoof capsule withstands load in proportion to its cross sectional area. A combination of increased weight on the heels of the foot and the protection of the horn at the toe by a fitted shoe prevents natural exfoliation leading to the stress loading capabilities of the horn being exceeded resulting in dished toes and crushed heels.

The excess of toe also increases the force required to achieve kinetic break over. This increase in force will be reflected in friction wear at the toe.

Fig 12



The influence of the turning force created by the moment arm compressing the heel

100% of all shoes studied had friction wear of the toe. The roller motion of break over caused "Toe wear" on the shoes. This is seen in two specific areas at a different angle to the ground bearing surface of the shoe and either at the centre of the toe or to the outside of the toe. The position of Toe Wear appeared to be determined by conformation and the relationship of the centre of the toe to the centre of the Knee.

Friction wear of the toe is a result of starting and maintaining locomotion. Shoes tend to wear more on hard surfaces such as the road because of a reduction in traction and the inability of the foot to cut into the surface hindering its natural function. On soft ground the foot cuts into the ground with rotation of the pedal bone around the centre of the Distal Interphalangeal Joint.

Contributory factors for excess friction wear at the toe are on excess of horn at the toe and vices such as horses pawing the ground while boxed.

Descending heel wear was found on a small percentage of shoes mainly on the extremity of the out side heel and at a different angle to the ground surface wear of the shoe. This indicates impact of the outside heel before the ground-bearing surface of the shoe.

The friction wear in this case is at a different angle to the ground surface friction wear and has great implication on the turning moment from the centre of the foot to the heels.

CONCLUSION

Shoe wear assessment reveals a difference between impact wear and friction wear through slippage. The results of this study have shown that uneven impact of the foot results in uneven wear. An evenly worn shoe is the result of level impact and even loading during the slip phase (Pardoe et al) before the foot becomes static in order to fully bear weight.

Shoe wear does not reflect the effects of full weight bearing and loading. During the load bearing phase of any stride the limb is static and as such can only reflect the forces placed on it. Therefore the hoof capsule can be the only indicator by which full loading and or motion can be visually measured.

Hoof capsule distortion is a direct result of the abnormal loads placed on it during loading in the stance phase of the stride. It is "squeezed" between gravitational forces in both the verticals and horizontal axis and the ground reaction force. Newton's laws of motion state that every force induces and equal and opposite reaction, along the line of the action of the said force.

In assessing and trimming requirements, account must be taken of shoe wear (to assess impact forces) hoof capsule distortion (to assess both remote and direct gravitational forces) and individual conformation in order to minimise the effects of abnormal direct vertical loads. As such the rigid application of current horizontal axis theories (T Square) is at best limited to those individuals with conformation that would fall in a limited band of tolerance from the accepted ideal.

Newton's Laws of Motion (17th Century)

1. A body continues in a state of rest, or of uniform motion in a straight line, unless or until acted upon by a force.

2. The acceleration of a body is proportional to the force acting upon it, and takes place along the line of action of the said force.

3. Every force induces an equal and opposite reaction.

This first law defines the term Force. Force is something which, by its self, produces an acceleration. No earthly body ever observed has a "natural" motion unaffected by force.

The second law is concerned with proportionality i.e. If a horse moves at 2 meters per second, we can state with confidence that the distance travelled is proportional to the time taken the acceleration of the horses body is proportional to the force acting on it.

The third law is probably the most difficult to deal with, when a force exists between two separate bodies A and B, the force exerted upon B by A is exactly equal to the force exerted upon A by B but opposite in direction. Newton's third law makes the assertion that the Earth is being pulled up by your body with the same force that the Earth pulls you down to it (Gravity).

Table 1

Annex B

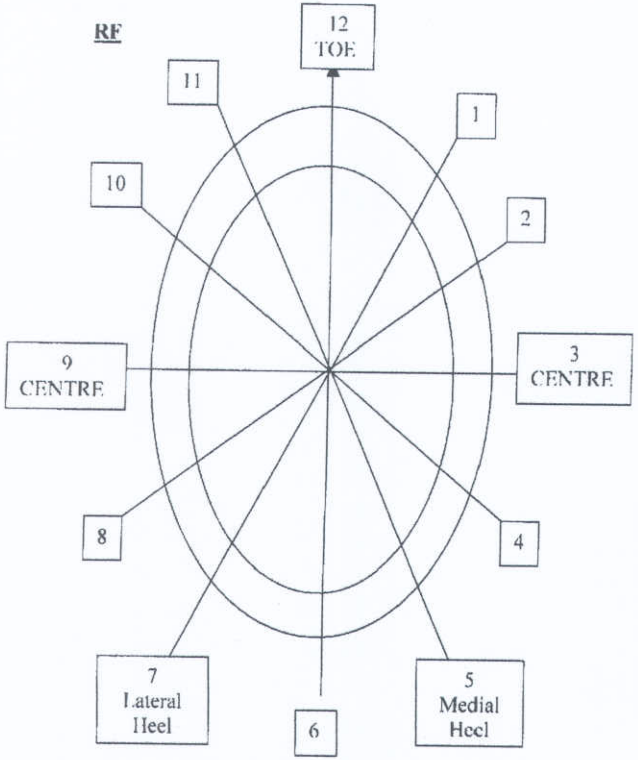
Shoe Wear Study Target Group		
	Group 1 **Ride and Drive**	**Group 2** **Riding School**
Number	Fifteen horses ride and drive	Thirty five horses used for riding instruction
Breed	Three Quarter Irish Draught Cross Thoroughbred	Three Quarter Irish Draught Cross Thoroughbred
Type of Work	Ceremonial Draft Parades Road Riding School	Riding school Road Cross country
Frequency of work	Daily one and a half hour road exercise (approx. 8-10 miles) Three times weekly Draft work 3hours (5 mile road exercise to and from exercise area) Sunday rest	Alternative daily one and a half hours road work (approx. 8-10 miles) Alternative daily one and a half hours indoor school (approx. 5-6 miles) Cross country twice a week weather permitting Sunday half-hour horse walker.
Type of work surface	Metalled roads Agricultural land Fibre Sand Sand manage	Metalled roads Agricultural land Fibre Sand Sand manage
Conformation	Vertical rotated axis Fetlock Valgus Fetlock Varus Toe in Toe Out Base wide Base narrow Broken Back Broken forward	Vertical rotated axis Fetlock Valgus Fetlock Varus Toe in Toe Out Base wide Base narrow Broken Back Broken forward
Gun team position	Lead Centre Wheeler	N/A

Shoe wear record form Left and Right

SHOE WEAR
GROUND SURFACE

Name.................... No...................

RF

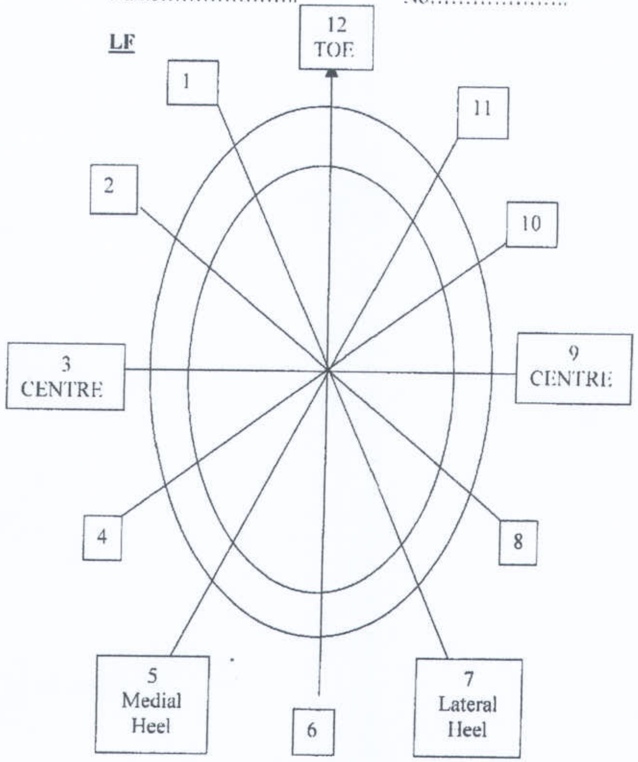


Remarks L C W
Hoof Capsule Distortion:
Conformation:

SHOE WEAR
GROUND SURFACE

Name.................... No...................

LF



Remarks L C W
Hoof Capsule Distortion:
Conformation:

Army Book 71 (AB71) Shoeing Record

SQUADRON, BATTERY or COMPANY: FORGE DAC — 2000

ROLL OF SHOEING.

Army No.	Size of Shoe Fore	Size of Shoe Hind	Month, Date Shod	Date Removed	By whom shod	Remarks	
PAYTON	7	/	COTT	15.5	BENNETT		1
SPYCATCHER	9	/	15.5	PLG'S	MACDONALD		1
?	DFG		16/5		BENNETT		1
NULA	DFG		-"-		IRETON		2
DENNIS	DFG		-"-		MACDONALD		1
COLEEN	DFG		-"-		IRETON		1
LIGHTNING	DFG		-"-		MACDONALD		1
UMBRO	18	18½	17/5	HM	MADDEN BENNETT	IRETON MACDONALD	1
SPYCATCHER	/	13¾	-"-	HMFC	IRETON	MACDONALD	1
ZIA	/		-"-		BENNETT	FOOT SEARCH	6
HENLY	/		-"-		BENNETT	NUMBERS	3
L. LADY	/		19/5		MACDONALD	TRADE TEST	1
TARNISH	/		-"-		IRETON	-"-	1
PAYTON	/		20/5	PLG	MADDEN		1
RILEY	DFG		22/5	1	ROBERTS		1
T/ABOUT	/	7	-"-		CARROLL	DEAN	1
W/PROMISE	/	9	-"-		LANE	DEAN	1
7876	DFG		-"-		ROBERTS		1
VOLTAIRE	/	8	-"-		LANE	LANE	2
7826	DFG		-"-		ROBERTS		1
TRAVIS	7	6	-"-	COTT	LANE	DEAN	1
TARNISH	9	RF	-"-		CARROLL	LEFT F + HIND (LAME)	1

SQUADRON, BATTERY or COMPANY: FORGE DAC — 2000

ROLL OF SHOEING

Army No.	Size of Shoe Fore	Size of Shoe Hind	Month, Date Shod	Date Removed	By whom shod	Remarks	
VAMARE	8	/	22/5		LANE	DEAN	1
VIENNA	6	5	23.5	COTT	CARROLL	DEAN	1
ROWEATH	6	5	-"-	-"-	MADDEN	ROBERTS	1
RAMKETT	/	8¼	-"-	HMFC	MADDEN		1
OLRIKA	/	/	-"-		MADDEN	FOOT SEARCH SENSITIVE ABCESS	6
SUBALTERN	/	6	-"-	COTT	DEAN		1
VALLEY F	/	6	-"-	PLG	MADDEN		1
HENLEY	6	12¼	24/5	PLG	MADDEN	ROBERTS	6
W. MELTON	S	6	24/5	BLS RG	MADDEN		1
J. CON	/	6	25/5	COTT	CARROLL		1
HIGHWAYMAN	/	8	-"-	"	LANE		1
SAMUEL	L/SHOE		-"-		DEAN		1
UNA	R/C		-"-		DEAN		7
RAFFLES	/	9	-"-		DEAN	LANE	1
HENLEY	DFG		-"-		DEAN		6
CALYPSO	6	/	-"-	COTT	CARROLL		1
7514	DFG		-"-				
7901							
7584					AJF		
7788							
7856							
7593							

BIBLIOGRAPHY

Hickmans Farriery (Second Edition) — Hickman and Humphrey

No foot no Horse — Gail Williams and Martin Deacon

Horseshoeing — Anton Lungwitz

Handbook of Horseshoeing — A.W Dollar and A Wheatly

Applied Mechanics Made Simple — George E. Drabble

Bio-Mechanics of the Musculo-skeletal System (Second Edition) — Beno M Nigg and Walter Herzog

Tutorial Articles

Determination Of The Centre Of The Pressure Of The Forelimbs Of Horses Standing On A Flat Level Surface. — P. Colahan, E .Lindsey, C. Nunuier

Investigation Of The Vertical Hoof Force Distribution In The Equine Forelimb With An Instrumented Horse Boot. — E. Barrey

The Hoof Mechanism — H. Smedegaard, S. Vindriis

Balancing the Normal Foot — O.K Balach, D. Butler, M. A. Collier

The Effects of shoe material on the Kinetics and kinematics of foot Slip at Impact on Concrete. — C. H. Pardoe, M. P. McGuigan, K. M. Rogers, L. L. Rowe, A. M. Wilson