SCIENCE OF SYNTHETIC TURF SURFACES: PLAYER INTERACTIONS

PHYSICAL PROPERTIES VERSUS PERFORMANCE TESTS

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SCIENCE OF SYNTHETIC TURF SURFACES: PRESENTATION OVERVIEW

INTRODUCTION

- The Playing Surface
- The Environment

COMPONENT BEHAVIOUR

- Infill
- Fibre

COMPOSITE BEHAVIOUR

- Force Reduction
- Hardness
- Ball Rebound
- Rotational Traction

SUMMARY

THE PLAYING SURFACE

PITCH CONSTRUCTION

- Synthetic carpet laid over or sometimes bonded to a shockpad, which in turn is laid over an engineered foundation.
- The main differences between pitch systems comes in the form of the carpet and shockpad layers.

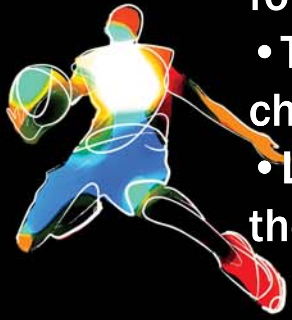
3rd GENERATION/3G SYNTHETIC TURF SURFACES

- Long pile carpet less densely packed, 35 mm - 65 mm in length, rubber crumb infill or a combination of sand (for stability) and rubber crumb
- Recognised by the international governing bodies of soccer (FIFA) and rugby union (IRB)

THE PLAYING SURFACE

- The variety of fibres, infill and installation techniques suggests that it is inevitable that differences in the properties of the overall systems exist.

- To try and limit the differences between pitch systems, performance requirements have been implemented.
    - For example FIFA state that rotational traction must fall between 25 – 50 Nm for a 2 Star pitch.
    - These requirements have reduced the differences in the playing characteristics to some extent.
    - Lack of published data or clear justification by the governing bodies on how these limits have been determined.



THE PLAYING SURFACE

- Most surface related studies have compared the mechanical behaviour and injury occurrence between natural and artificial surfaces.
- Recent studies on new generation turf have shown similar traction properties to natural turf.
- There has been little research into the science of synthetic turf surfaces and the properties influencing the performance behaviour.
- The wide acceptance of these surfaces for use in many sports suggests that there is now a greater need to better understand the underlying science of these surfaces.

THE ENVIRONMENT

- Generally environmental factors can be related to the ‘state’ of the playing surface (where it is situated, weather).

- Combination of environmental factors that cause a synthetic turf surface to degrade resulting in permanent changes to the properties and behaviour of a surface.

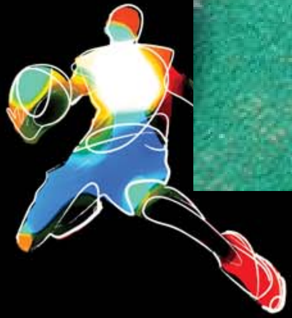
- There is limited data as to how the behaviour of a synthetic turf surface changes with time and usage and whether surfaces can maintain performance requirements set by sports governing bodies.

    - A current study by the Football Association (FA) carrying out spot tests on 3rd generation pitches two years after installation would suggest this is not the case with 8 out of 10 pitches failing one or more performance requirement (Williams, 2008).

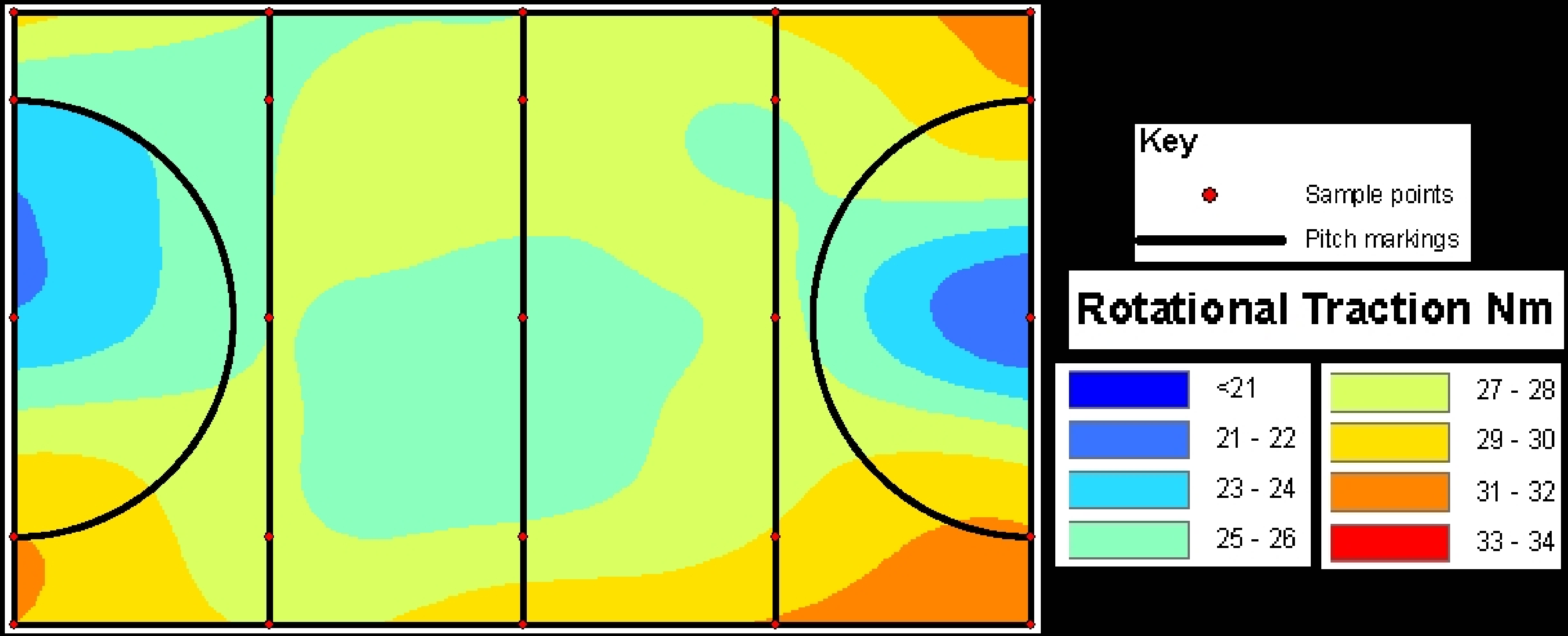
THE ENVIRONMENT

Recent field measurements of unfilled 'water based' pitches for field hockey highlighted significant spatial and temporal changes in the playing characteristics both over the surface of a single pitch and between (similar) pitches, including the test results for traction (Severn et al., 2007).

Wear of a 7 year old water based hockey pitch.



THE ENVIRONMENT



Spatial variation of rotational traction over a 7 year old hockey pitch

- Will a better understanding of the physical characteristics and properties of individual components help predict the behaviour of surface systems?
- Can we predict how a surface system will change with time and usage?
- Will this influence how we can maintain synthetic surfaces?
- Can performance testing be used as a measure of maintenance?

TO CHARACTERISE, CLASSIFY AND MEASURE THE PROPERTIES OF INDIVIDUAL COMPONENTS OF SYNTHETIC TURF SURFACES.

A breakdown of the playing surface variables.

Surface Layer (related to columns two and three)	Physical Characteristics	Mechanical Properties of Individual Components	Composite Material Mechanical Properties (Pitch System)
Fibre	Pile Height	Compressive Behaviour	Traction
	No. of Tufts per Unit Area	Surface Roughness	Hardness
	Fibre Material	Friction	Resilience
	Fibre Width	Tensile Strength	Stiffness
	Pile Weight		Penetration Stiffness
Infill	Material	Compaction (Bulk Density)	Tuft Withdrawal Force
	Size	Compression	Shear Strength
	Shape	Stiffness	
	Grading	Shear Strength	

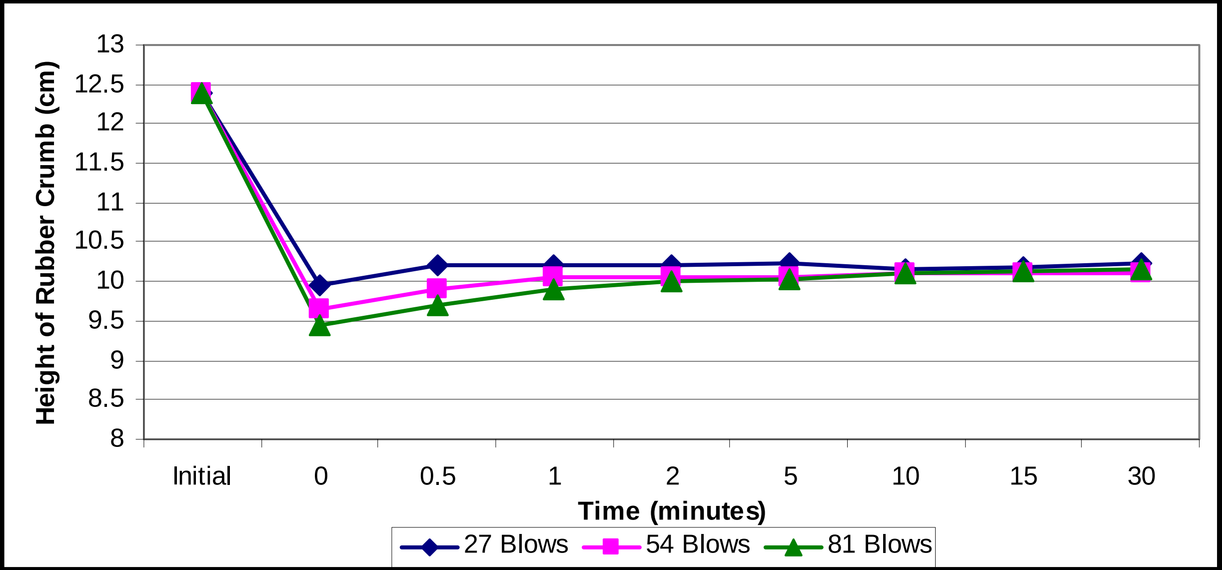
INFILL MATERIAL: AMBIENT SBR RUBBER CRUMB 0.5 – 1.5 MM

INFILL: COMPACTION

Permanent level of compaction can be achieved regardless of the elastic nature of the material.

This is due to the varying shapes and sizes of rubber crumb which allows for greater particle packing.

Decrease in infill height of approximately 23 mm.

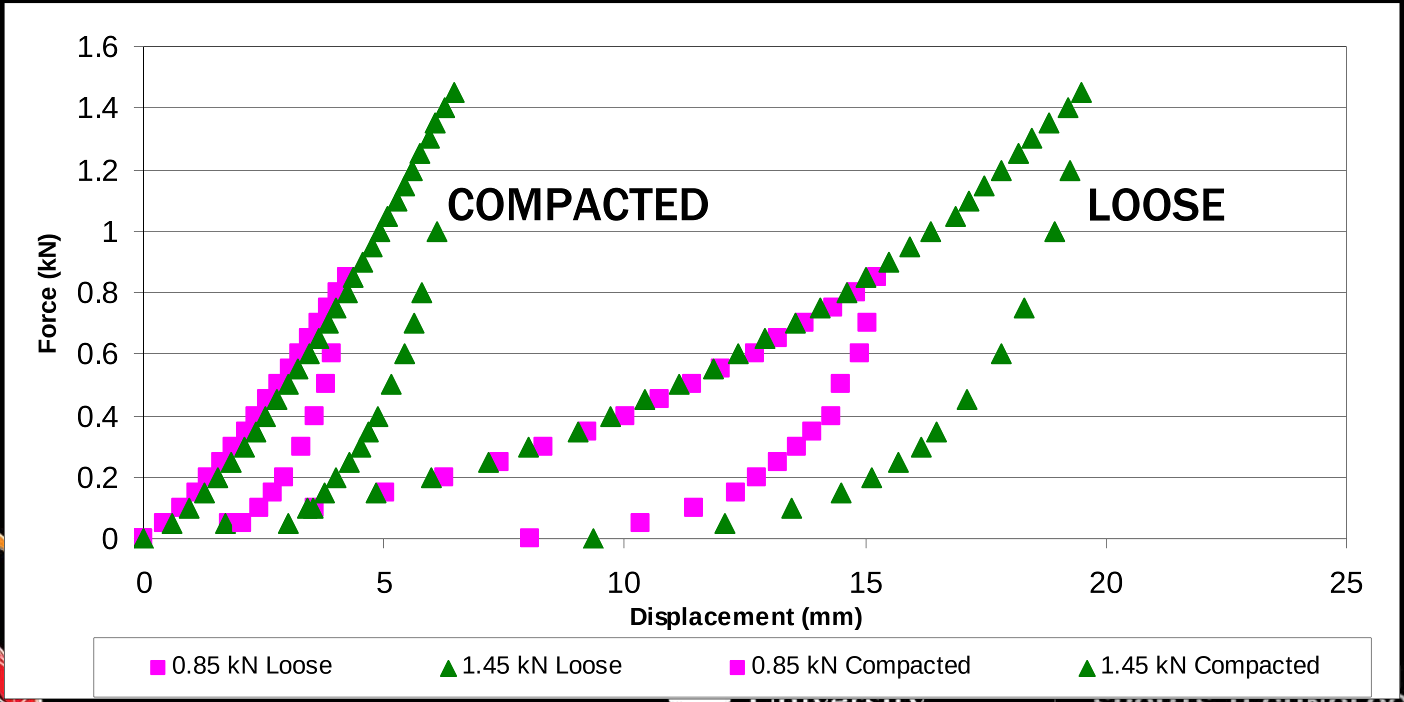


INFILL: COMPRESSION

Normal force increases the compression of the rubber crumb causing displacement to increase.

A reduction in compression from the loose to the compacted state. The compacted condition was much stiffer.

The loose conditions produced non recoverable displacement compared to the compacted conditions which recovered totally.

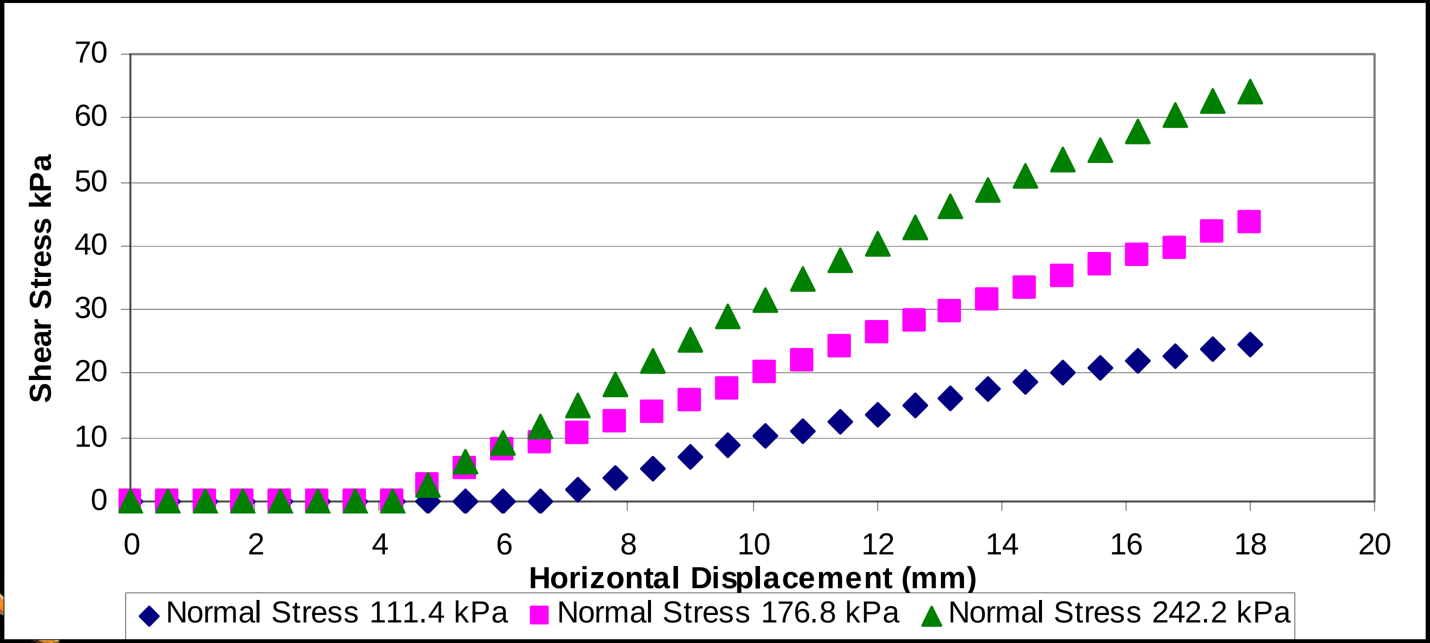


INFILL: SHEAR STRENGTH

It is assumed that in a surface system the greater the shear strength the larger the traction force.

Increasing the normal stress results in a higher shear strength.

Bulk density (determined by compaction and compression) of the rubber crumb determines the shear strength.



Shear stress of rubber crumb with increasing normal stress in a loose condition

FIBRE

SAMPLE	Carpet A	Carpet B	Carpet C
			
Fibre Material	Polypropylene	Polyethylene	Polyethylene
Fibre Type	Monofilament	Monotape	Monofilament
Melting Point ^{0}C	161.69 and (93.24)	129.21 and (164.80)	125.61 and (163.05)
Pile length (mm)	35	40	50
No. of Tufts per sqm	10600	25200	33600
No. of Fibres per Tuft	12	18	8
Fibre Width (mm)	1.5	1.5	1.3

TO INVESTIGATE THE EFFECT OF THE COMPOSITE BEHAVIOUR OF SYNTHETIC TURF SURFACES ON MECHANICAL PROPERTIES RELATING TO PLAYER AND BALL SURFACE INTERATIONS.

Surface systems:

- Three carpets varying in pile length and density
- Two shockpads varying in thickness (15 mm and 30 mm)
- Infill quantity depending on manufacturers specifications

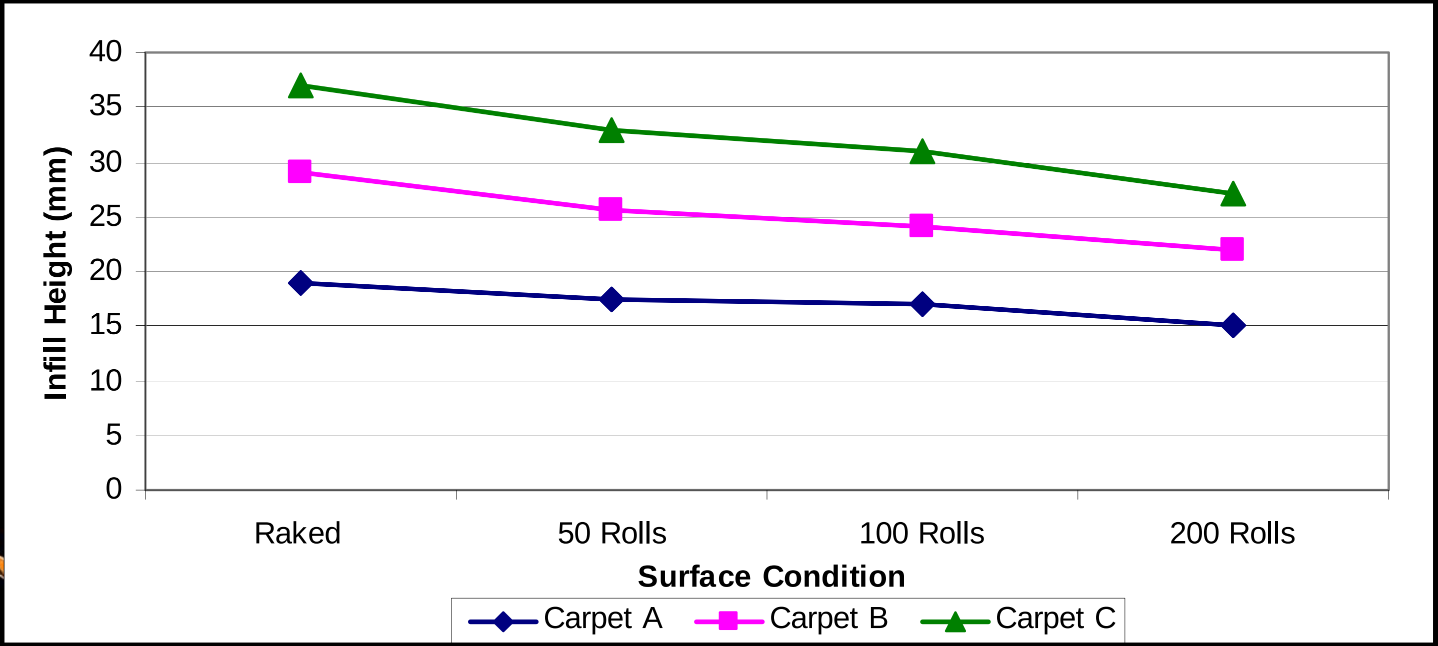
	Carpet A	Carpet B	Carpet C
Silica Sand 0.2 – 0.7 mm	10 kg	10 kg	10 kg
SBR Rubber Crumb 0.5 – 1.5 mm	4 kg	7 kg	12 kg

- Sporting mechanical tests including rotational traction, force reduction, hardness and ball rebound were used to measure the composite behaviour of the surface systems.

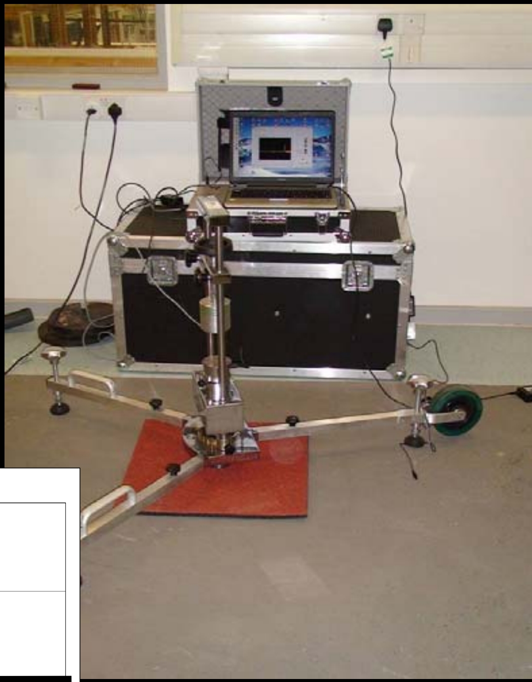
INFILL DENSITY

- Four surface conditions were created using a studded roller to compact the infill material.

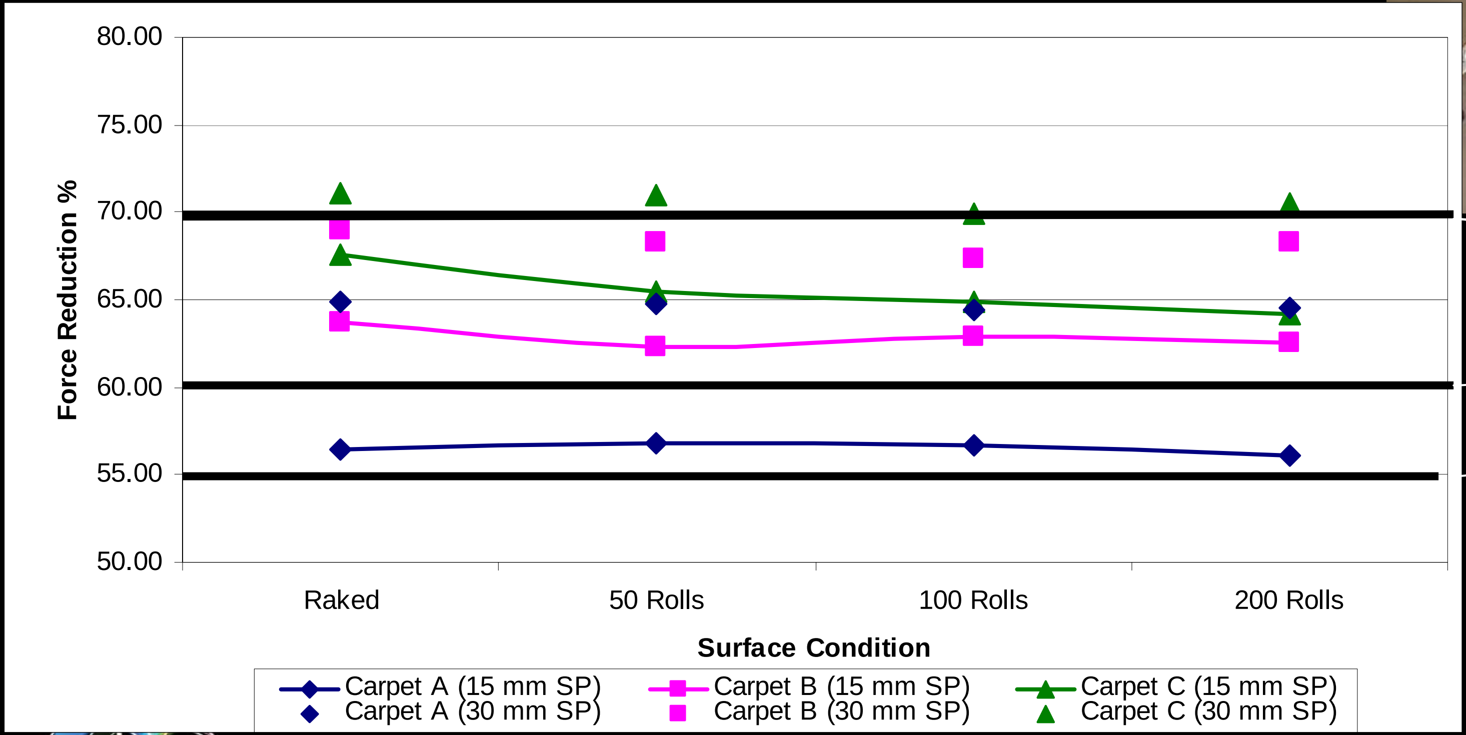
- The level of compaction and resulting bulk density of the infill material is dependent to an extent on the quantity of infill used and the carpet fibre in each surface system.



FORCE REDUCTION: ADVANCED ARTIFICIAL ATHLETE (AAA)



- Shockpad thickness affects the overall stiffness of the surface system.
- No significant difference in force reduction between different surface conditions.



FIFA 2*

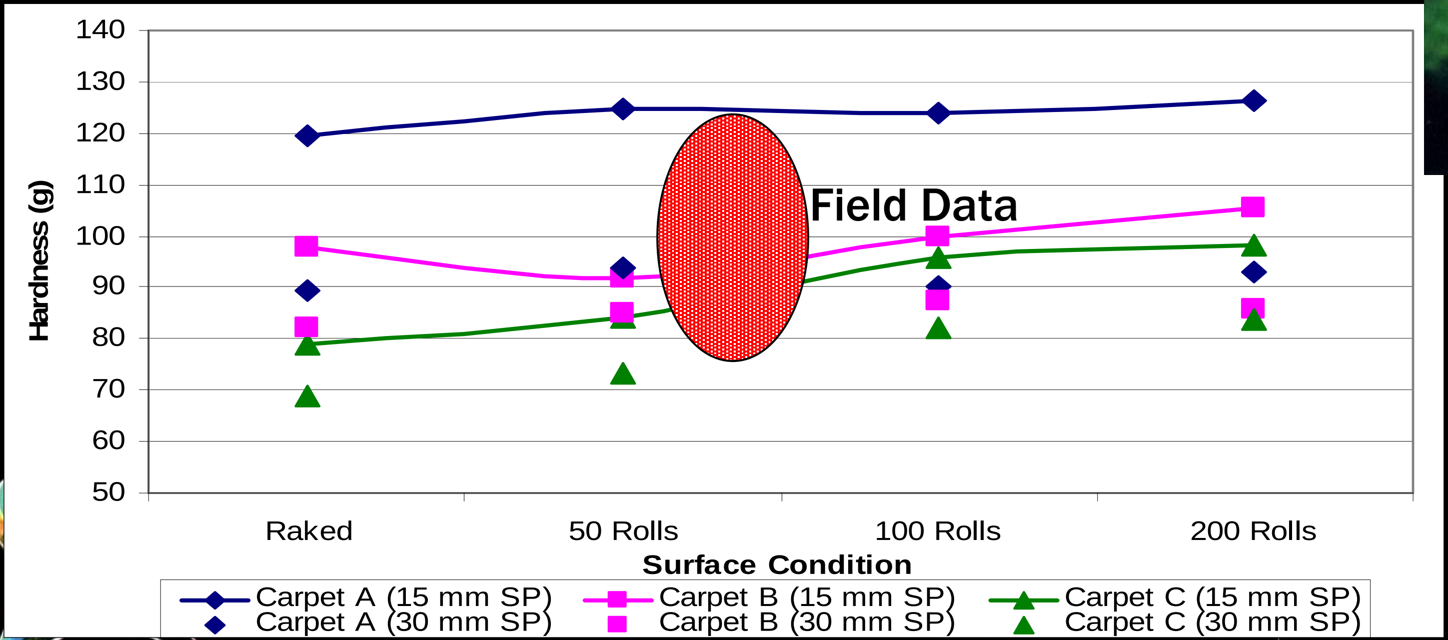
FIFA 1*

HARDNESS: 2.25 kg CLEGG HAMMER

- The shorter the pile length and reduced infill quantity increases the hardness of the surface system.

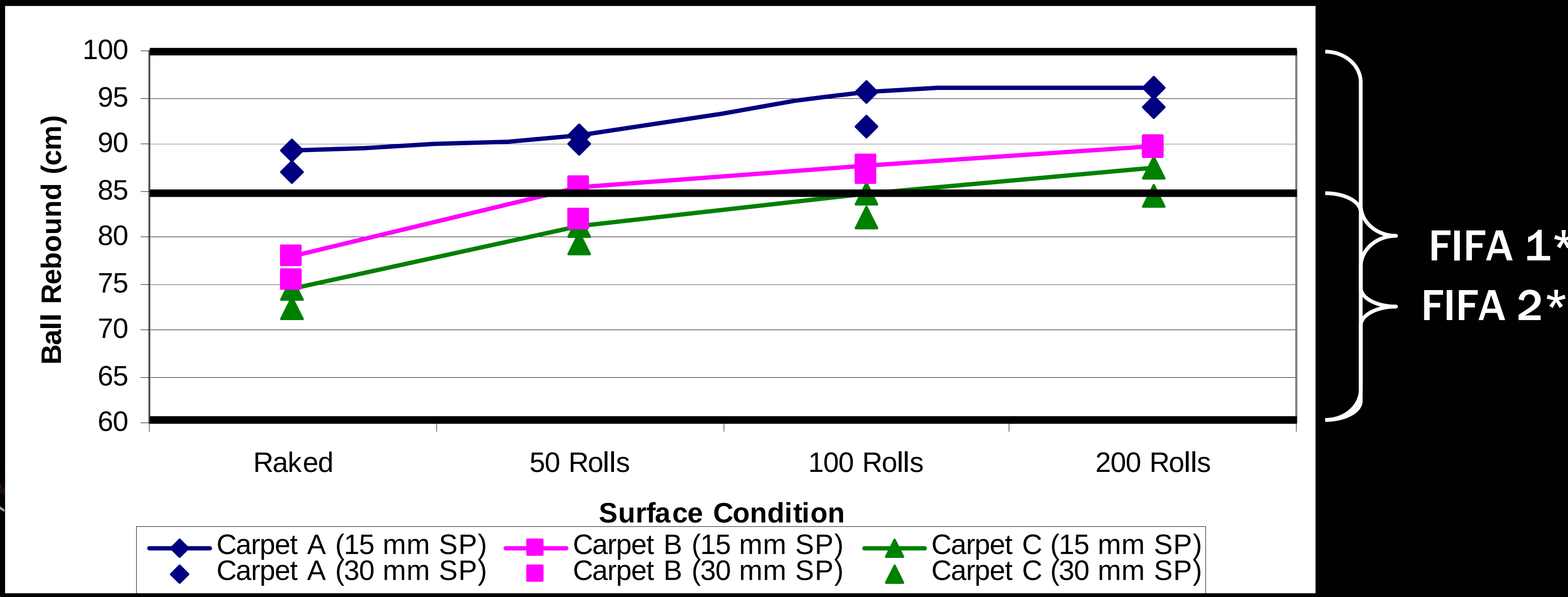
- Shockpad thickness affects the overall stiffness of the surface system.

- Clegg Hammer shows increase in stiffness with an increase in bulk density of the infill.



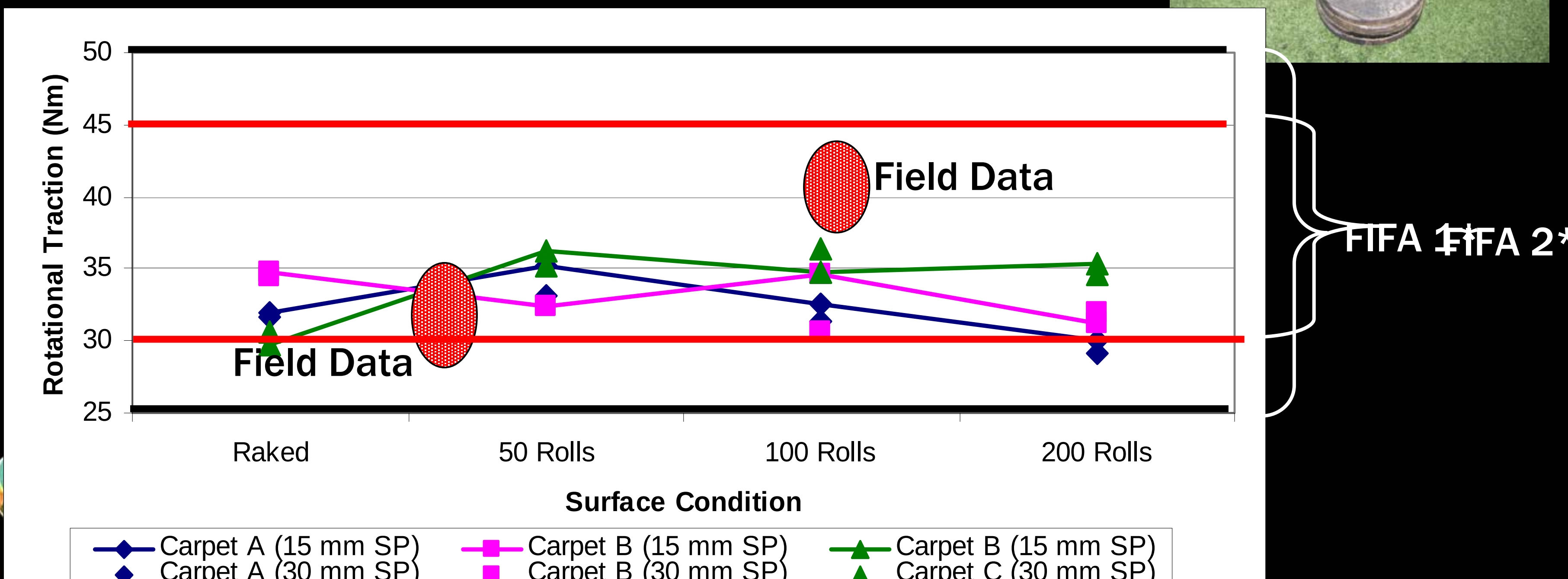
BALL REBOUND

- Height of pile fibre and subsequently greater quantities of infill reduce the height of rebound.
- Shockpad thickness affects the overall stiffness of the surface system.
- Ball rebound shows increase in stiffness with an increase in bulk density of the infill.



ROTATIONAL TRACTION

- No significant difference between the shockpad thickness was observed.
- No significant change in traction with increasing bulk density.
- How sensitive is the traction test method?



SCIENCE OF SYNTHETIC TURF SURFACES: SUMMARY

- Individual properties of a surface system such as the infill material can aid in predicting the performance behaviour of a pitch.

- The density achievable by the infill material in a surface system is reduced due to the carpet pile.

- Changing in the surface condition does influence the performance behaviour of surface systems.

- These tests were carried out on relatively new surface systems. The range of expected behaviour may change with older systems as the rotational traction results show.

- Performance testing could be a useful measure of maintenance.