



Improving surface quality of greyhound racing tracks



Prof. David Eager

School of Mechanical and Mechatronic Engineering

Faculty of Engineering and Information Technology

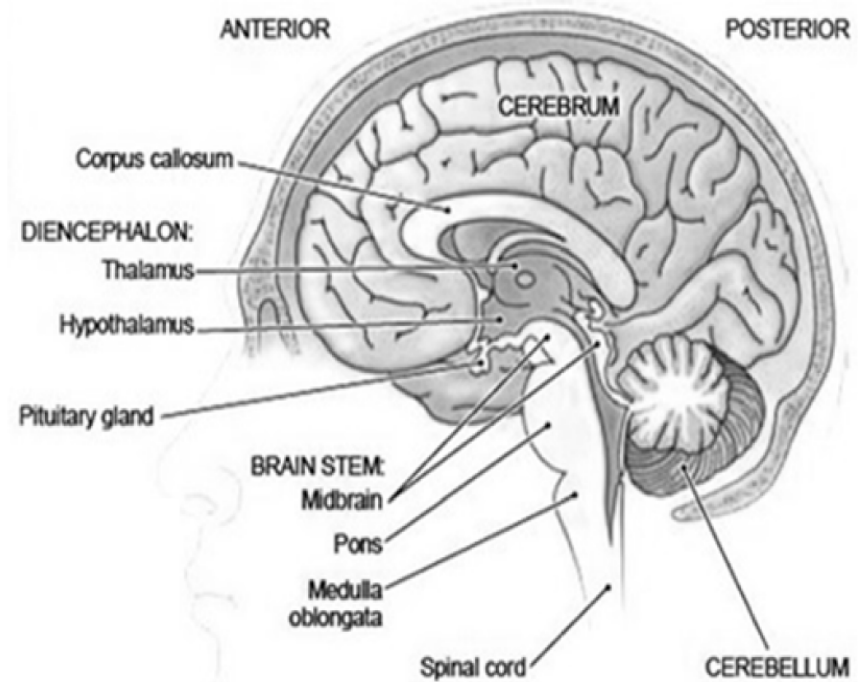
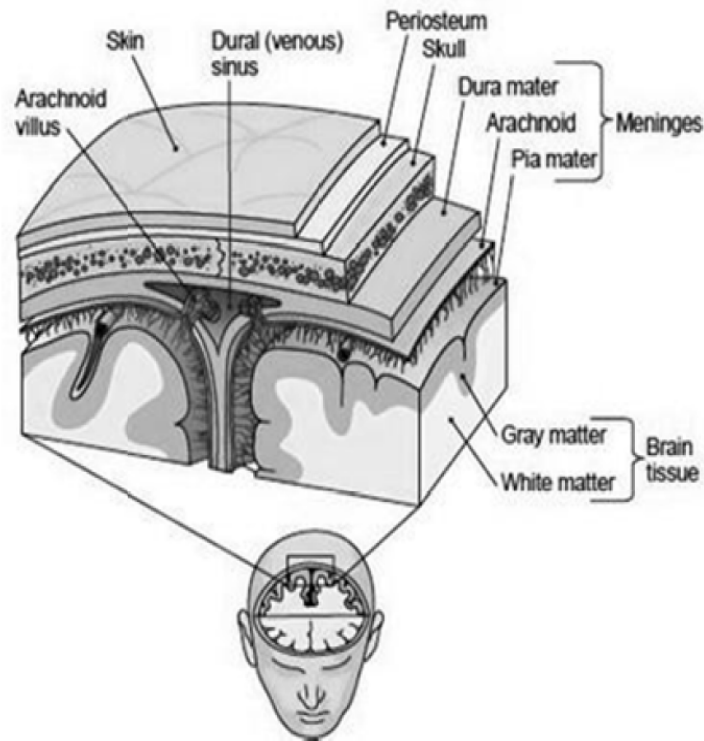
University of Technology Sydney



OUTLINE

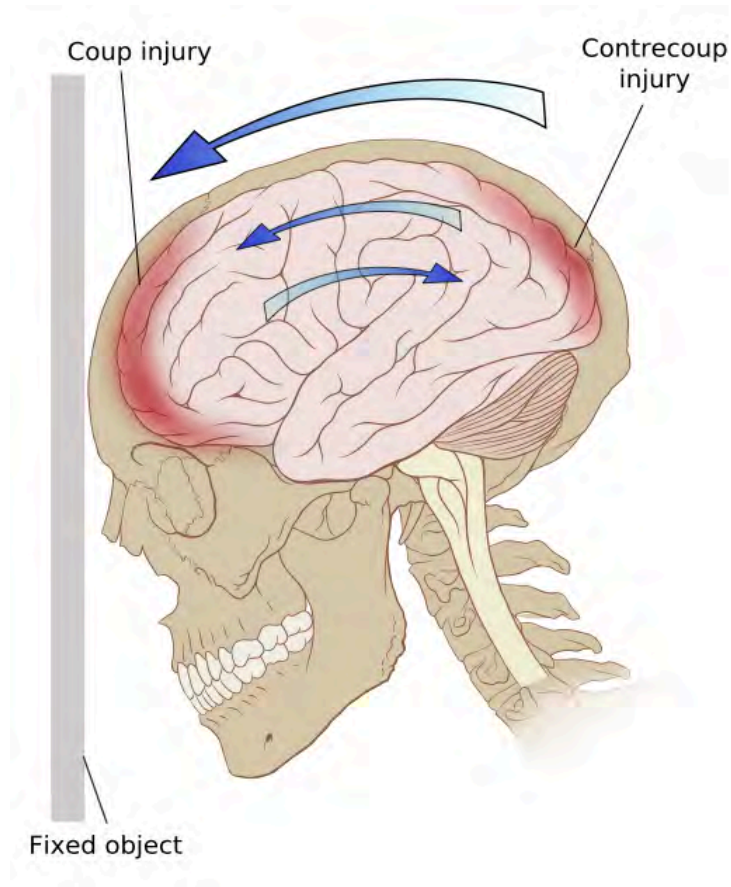
- Background | Need to have impact attenuation surfaces (IAS)
- Methods to assess the performance of IAS
 - Impact test
 - Simulations
- Improving track surface quality
 1. Is there any correlation between track parameters and severity and frequency of injuries
 2. Can we use HIC, G-max and delta-t as indicators of safety of racing tracks

BACKGROUND



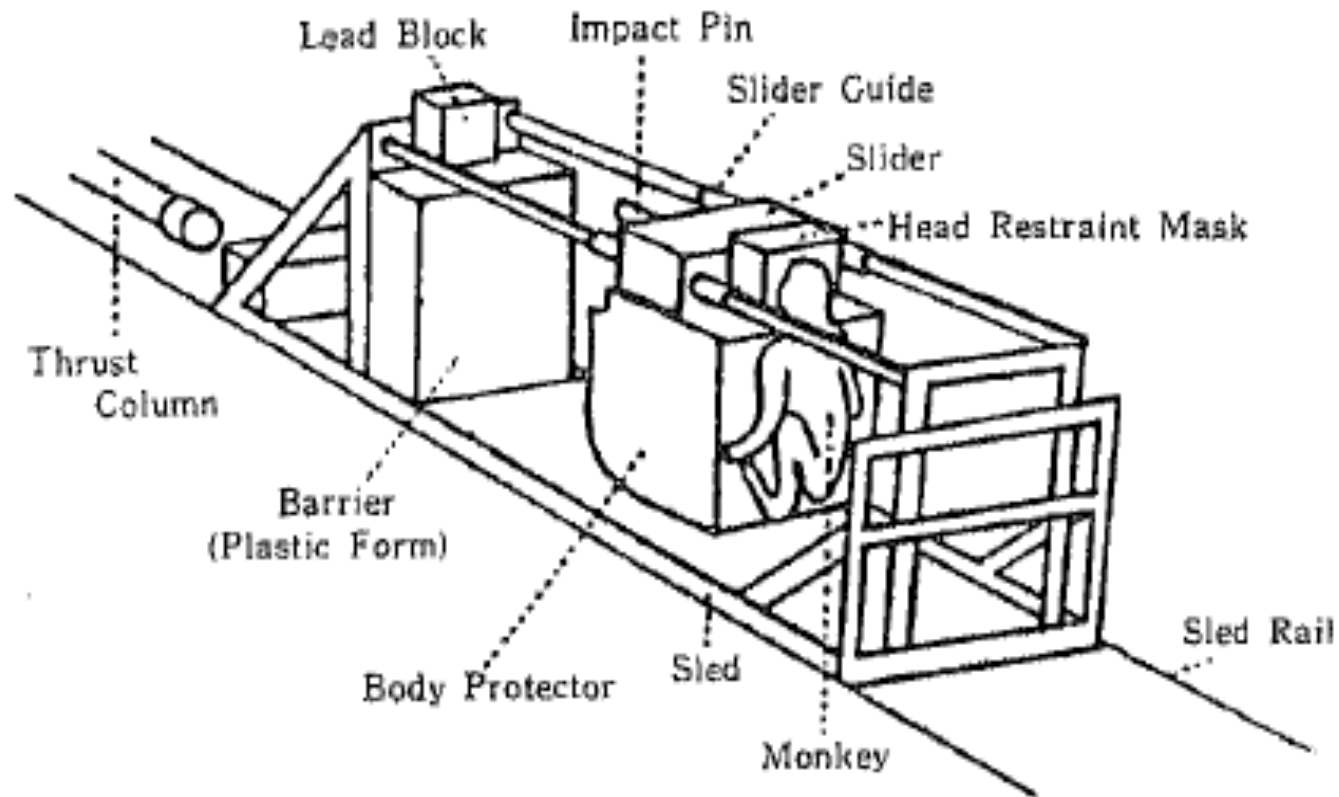
Anatomy of the head and brain

BACKGROUND



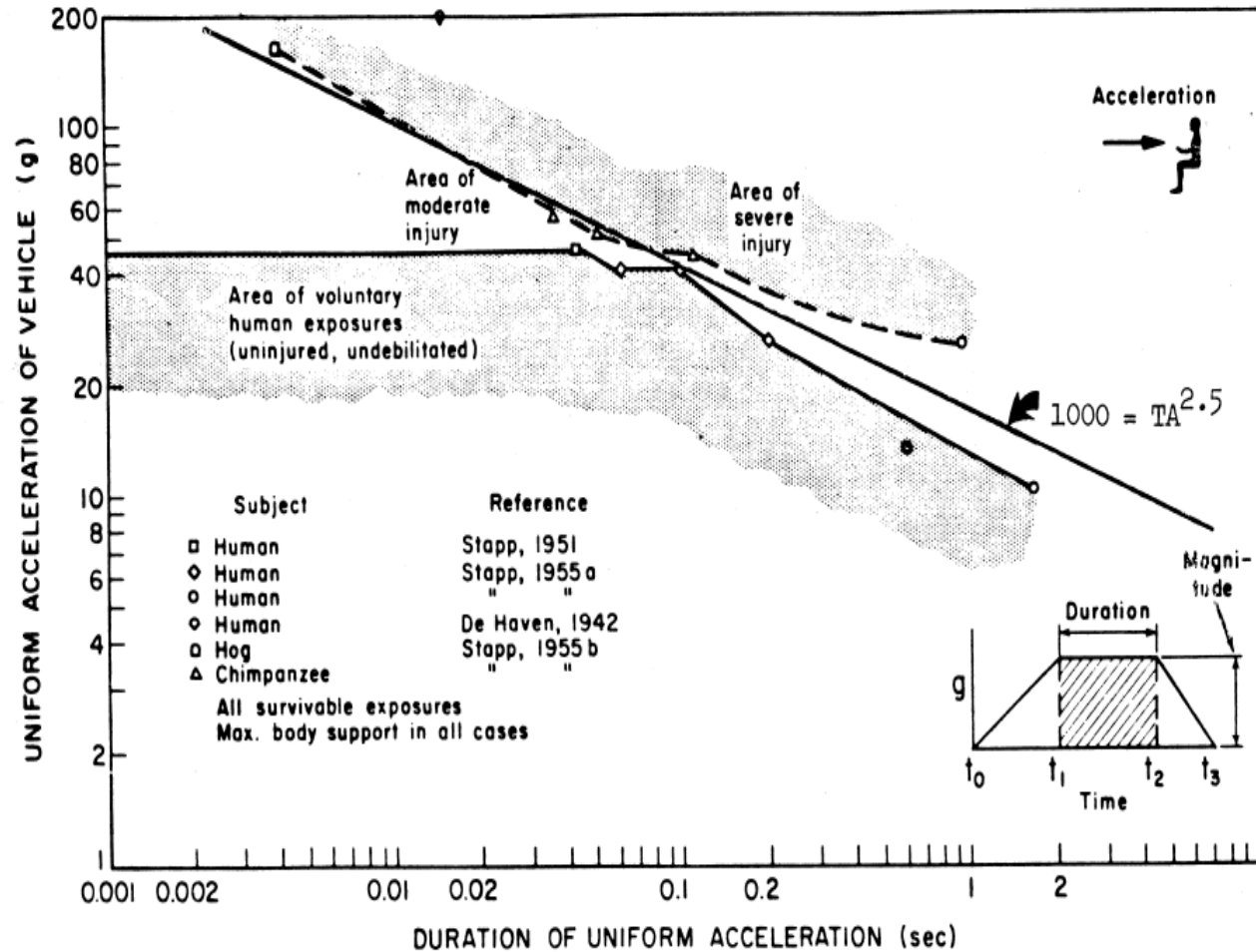
Negative and positive pressure,
rotation and shear effects

BACKGROUND



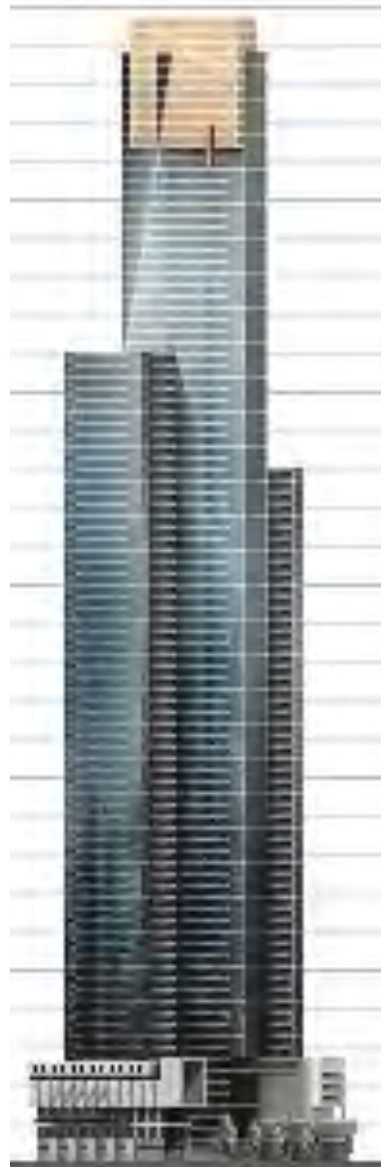
Sled used for translational impact of monkey head
JARI Human Head Impact Tolerance Curve (JHTC)

Head Injury Criteria



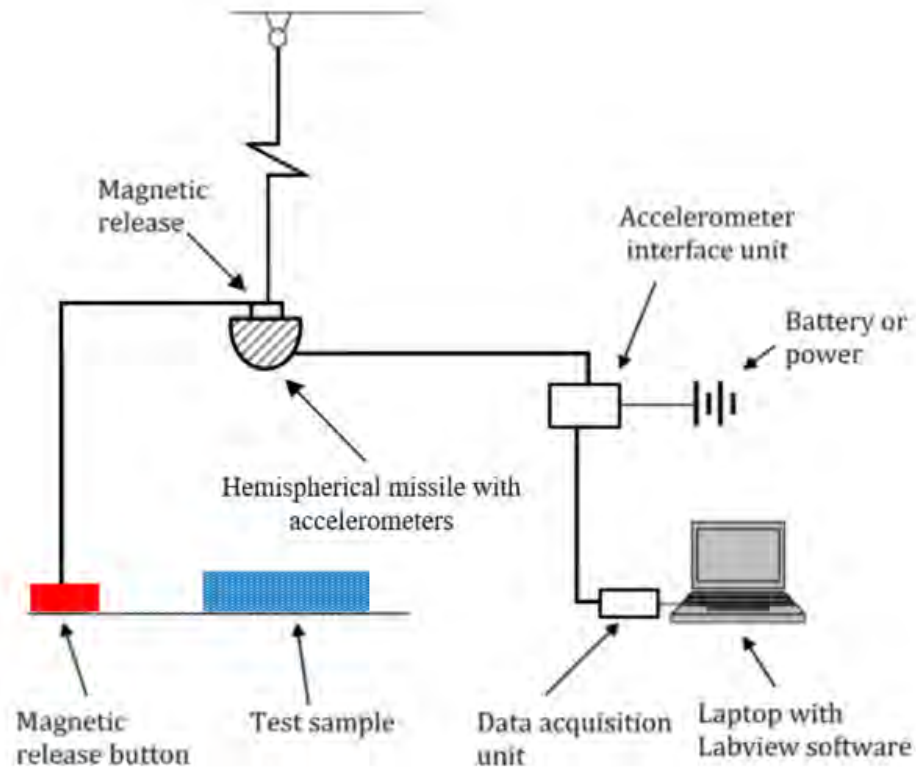
Human tolerance to rapidly applied accelerations: A summary of the literature (Eiband et al., 1959)

EUREKA TOWER | L7 FALL



20 m

IMPACT TEST



Impact attenuating surface testing apparatus

ACCEPTED HUMAN THRESHOLDS

1. Head Injury Criterion (HIC) less than 1000

$$\text{HIC} = \left[\left(\frac{\int_{t_1}^{t_2} a dt}{t_2 - t_1} \right)^{2.5} (t_2 - t_1) \right]_{\max}$$

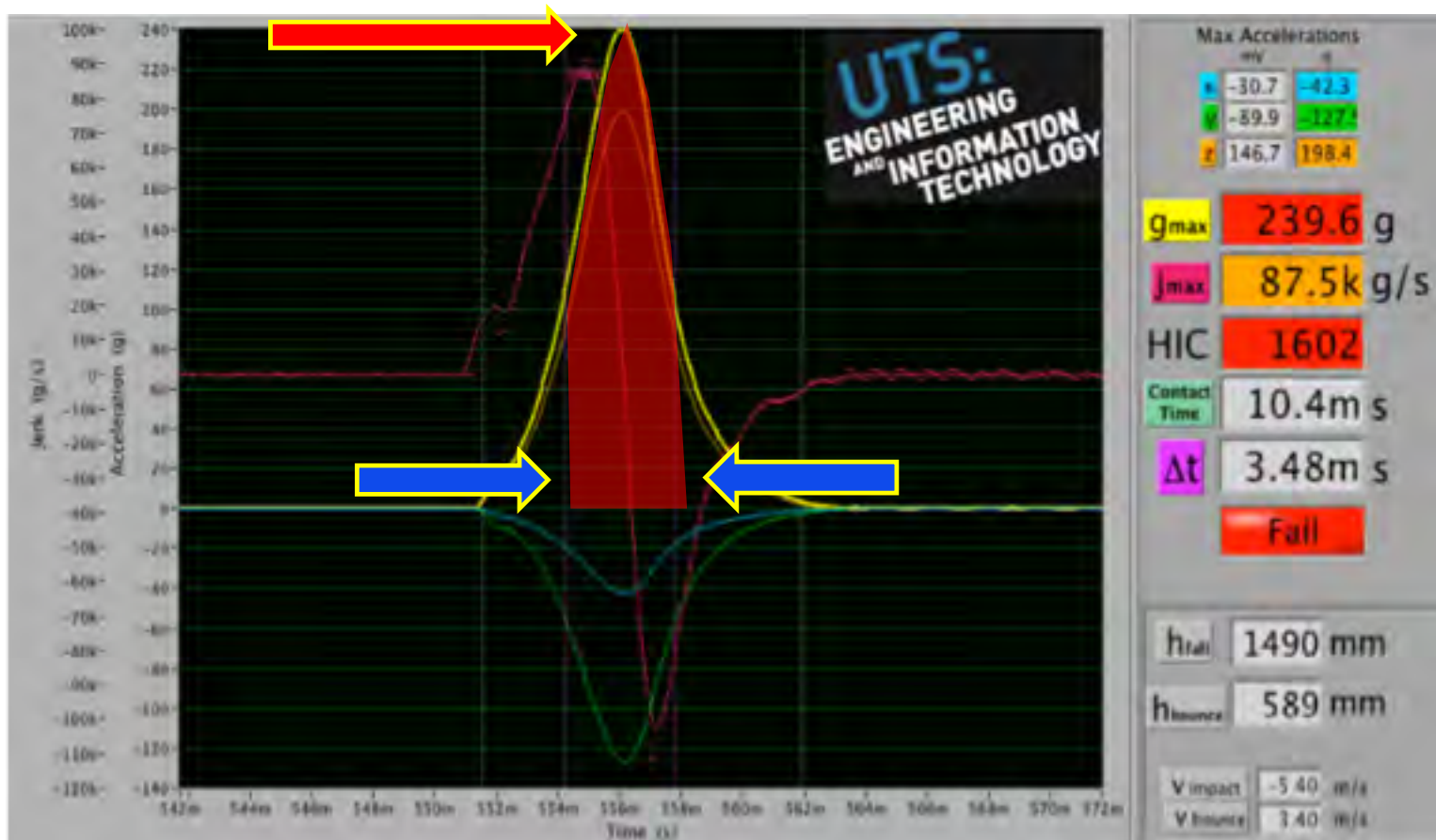
2. G-Max

➤ Maximum acceleration less than 200g

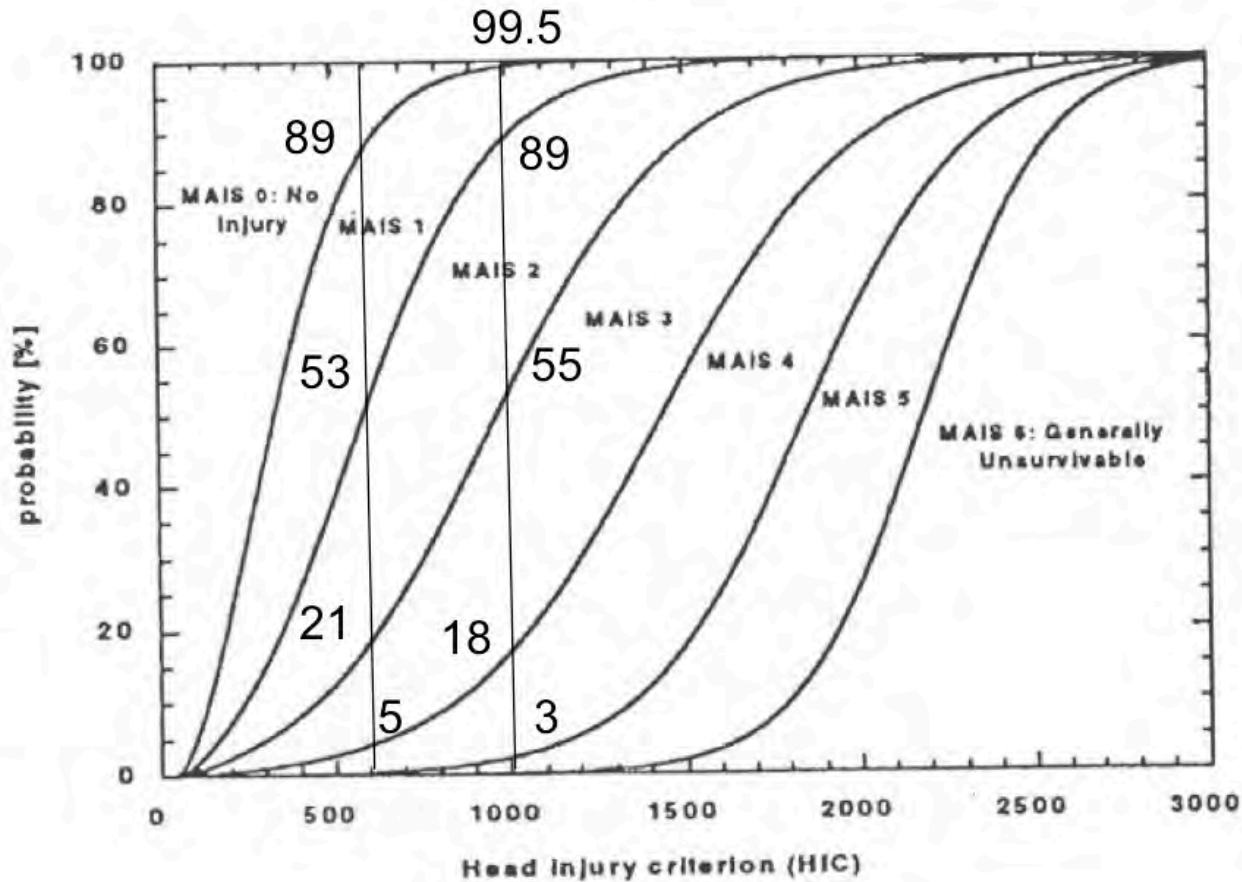
3. Delta-t

➤ Greater than 3 ms

METHODOLOGY



BACKGROUND

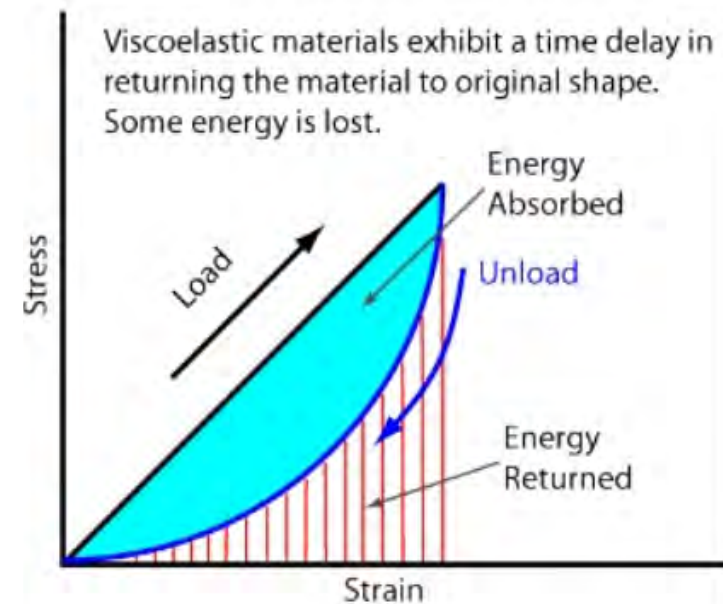


Prasad / Mertz Probability of a specific head injury

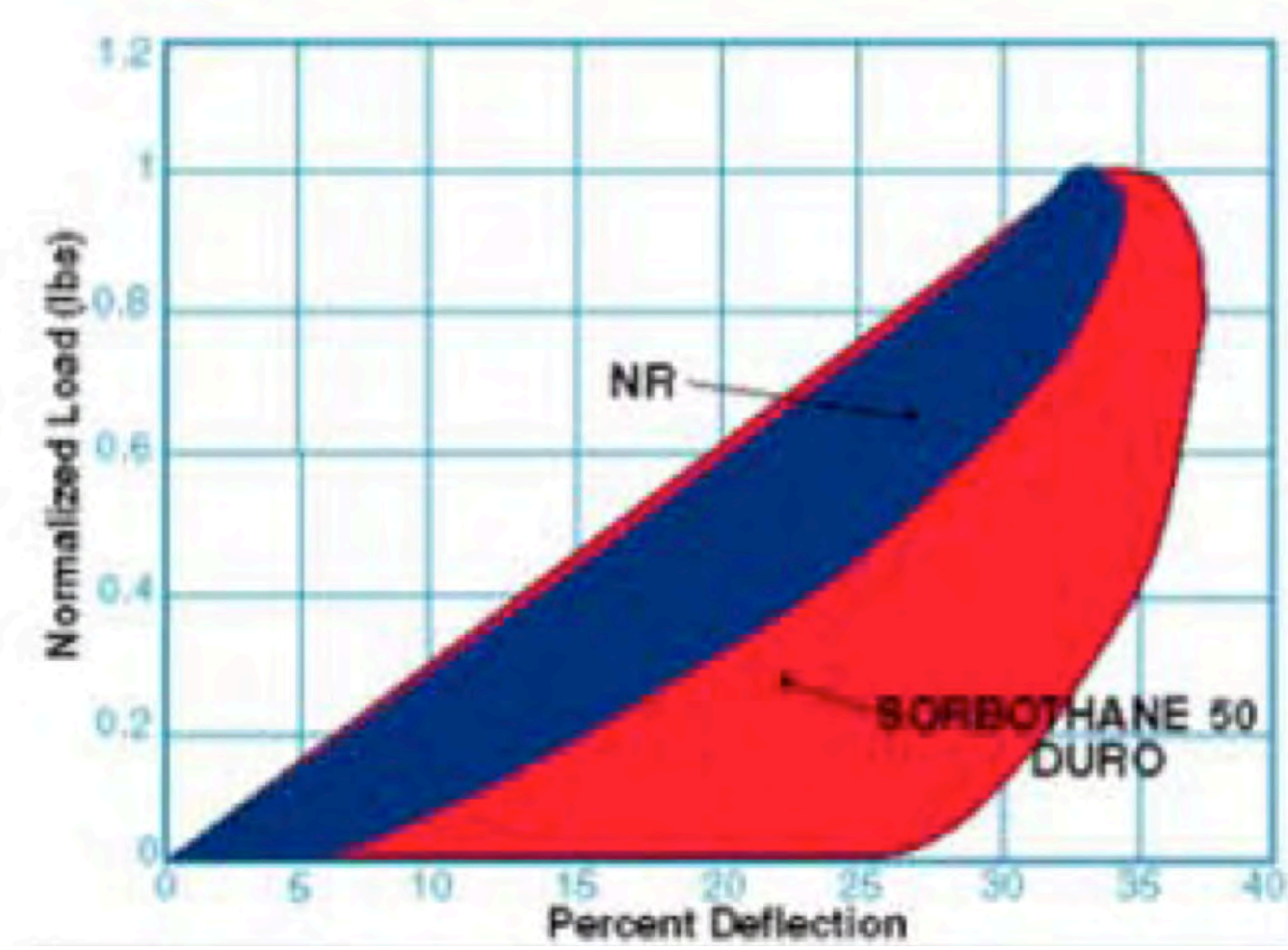
FORCE vs DEFORMATION

Viscoelastic materials

- ✓ The stress and strain behaviour is time-rate dependant
- ✓ Properties depend on load magnitude and rate at which load is applied
- ✓ These materials exhibit both fluid (viscosity) and solid (elasticity) properties
- ✓ These materials exhibit hysteresis
- ✓ Loading and unloading curves differ
- ✓ Energy is dissipated during loading

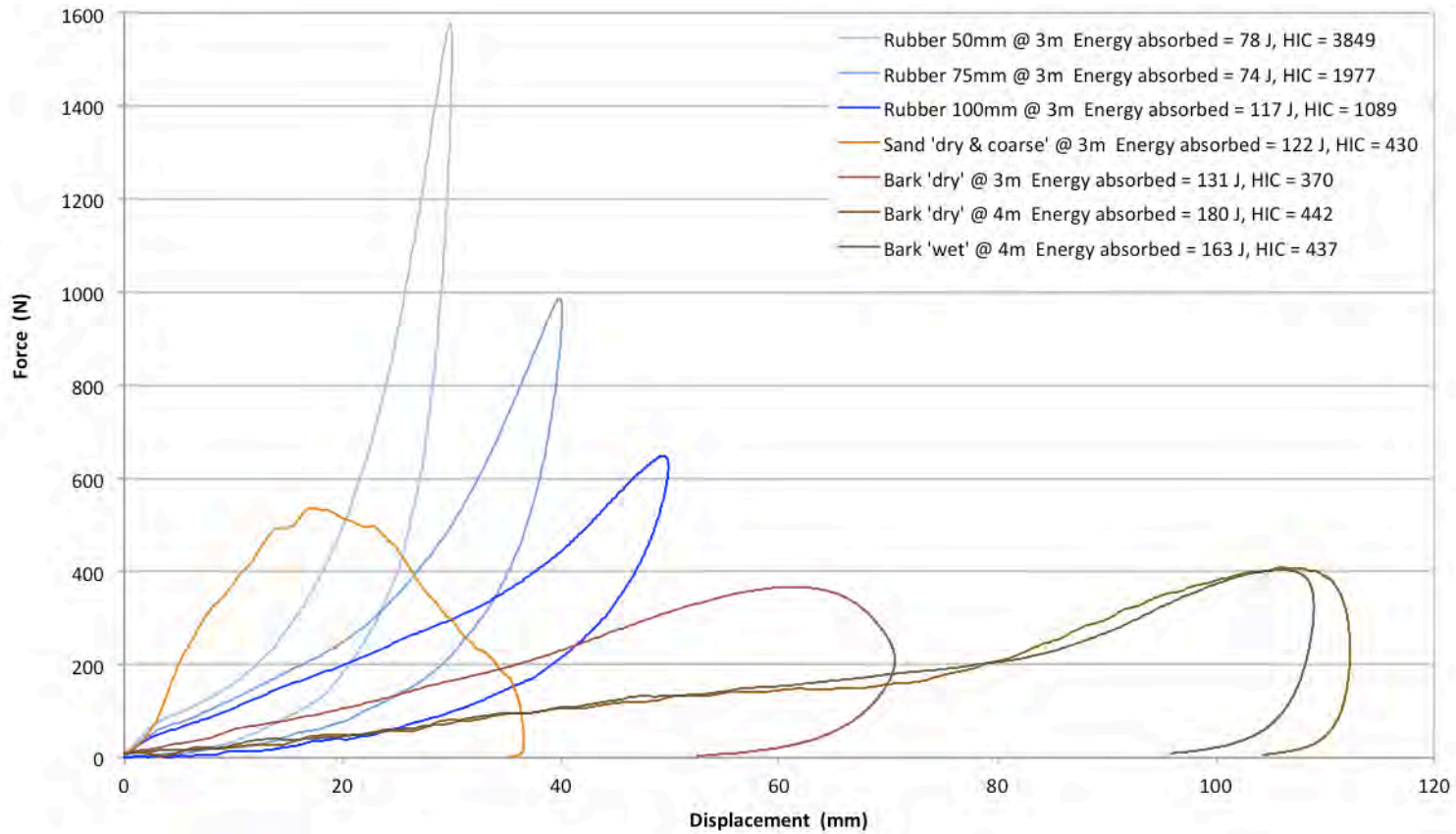


FORCE vs DEFORMATION



Sorbothane and natural rubber

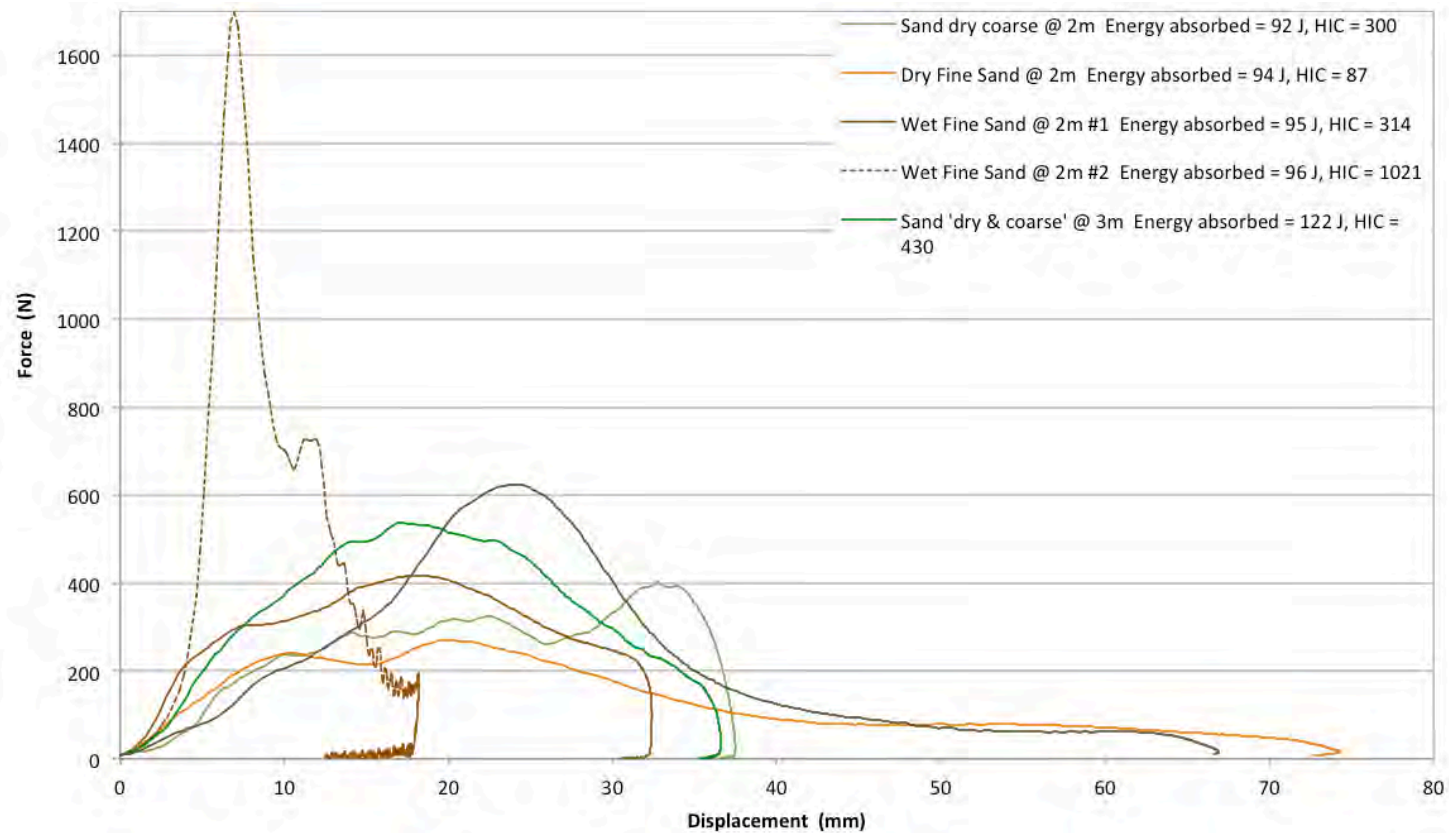
FORCE vs DEFORMATION



Force v Displacement hysteresis curves

Rubber, sand & bark @ 3 m & 4 m FHoF

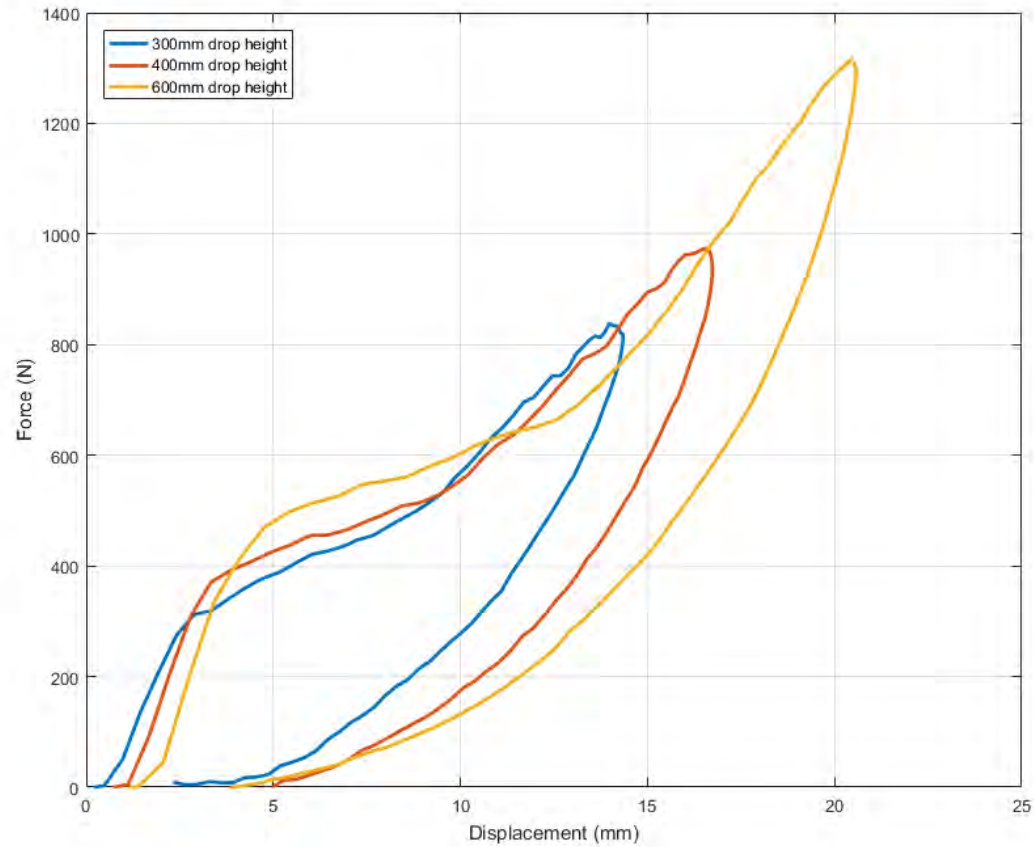
FORCE vs DEFORMATION



Force v Displacement hysteresis curves

rubber & bark @ 1m FHoF

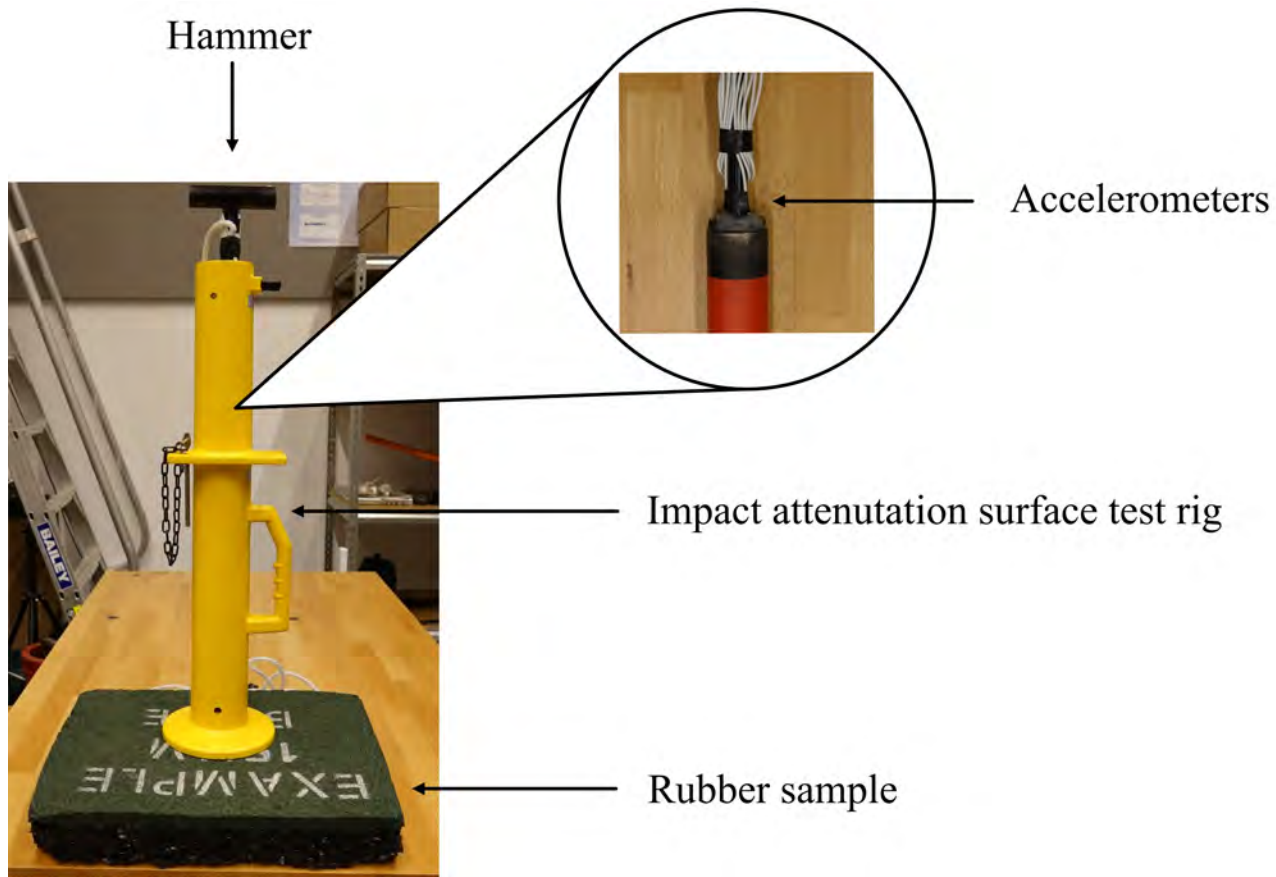
FORCE vs DEFORMATION



70 mm thick rubber playground surface

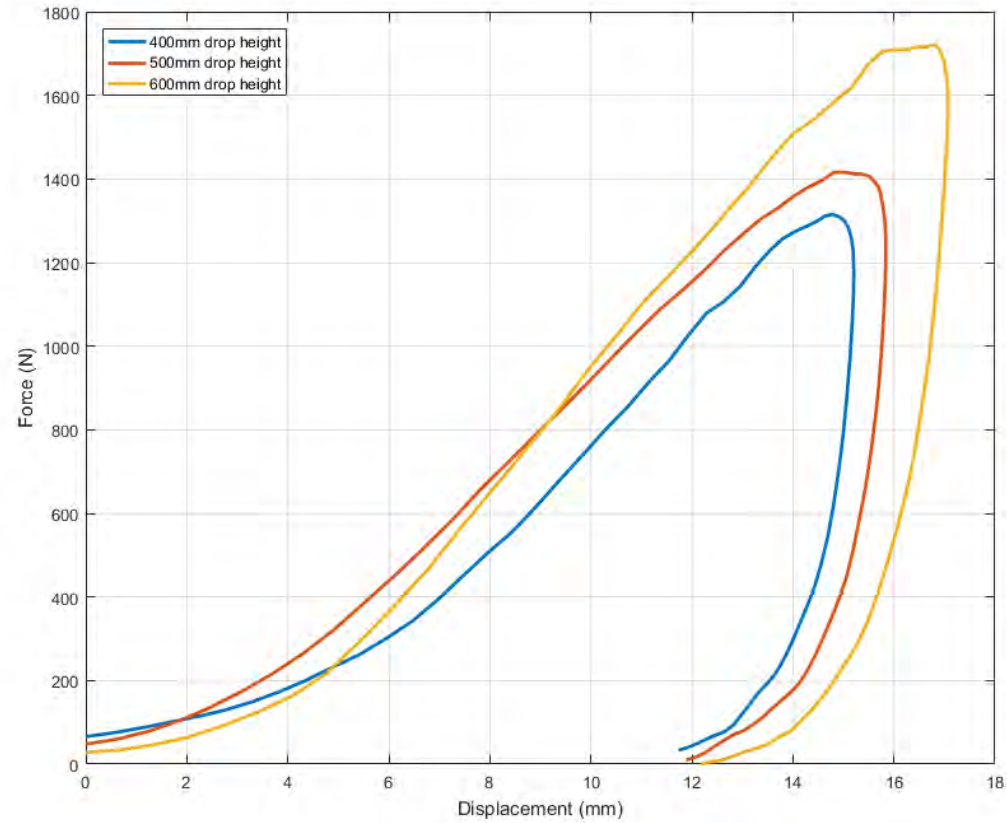
300 mm, 400 mm and 600 mm drop height

METHODOLOGY | TEST RIG



Clegg hammer test rig

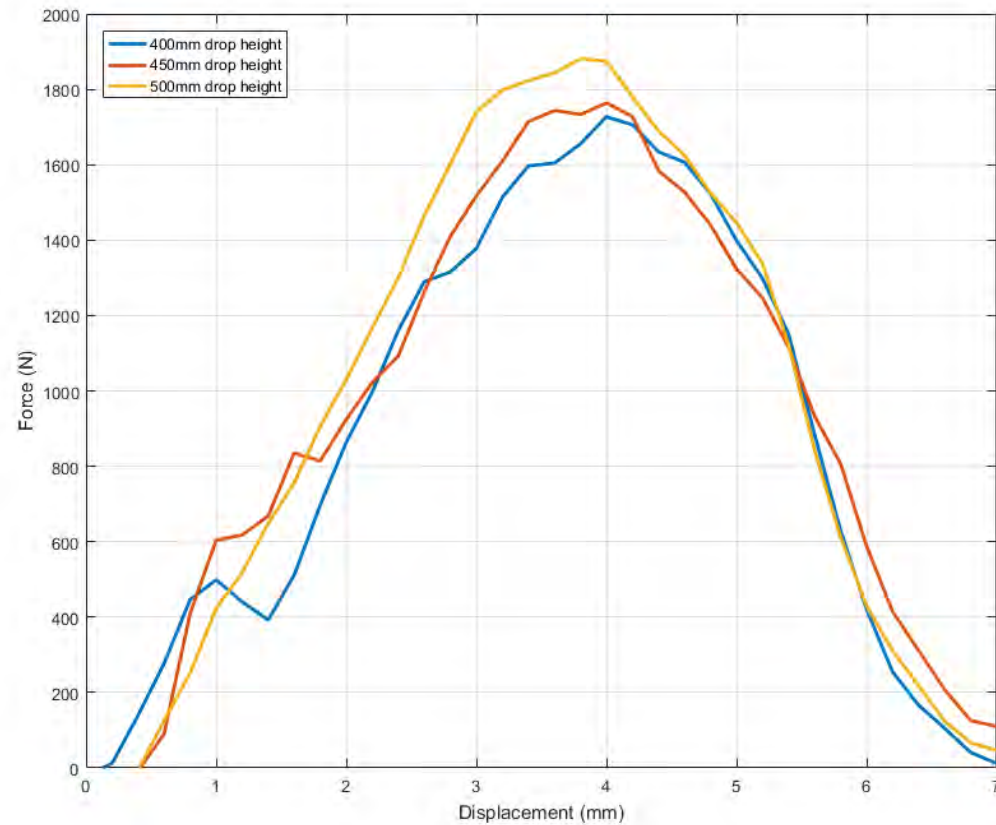
FORCE vs DEFORMATION



Cessnock natural grass surface

400 mm, 500 mm and 600 mm drop height

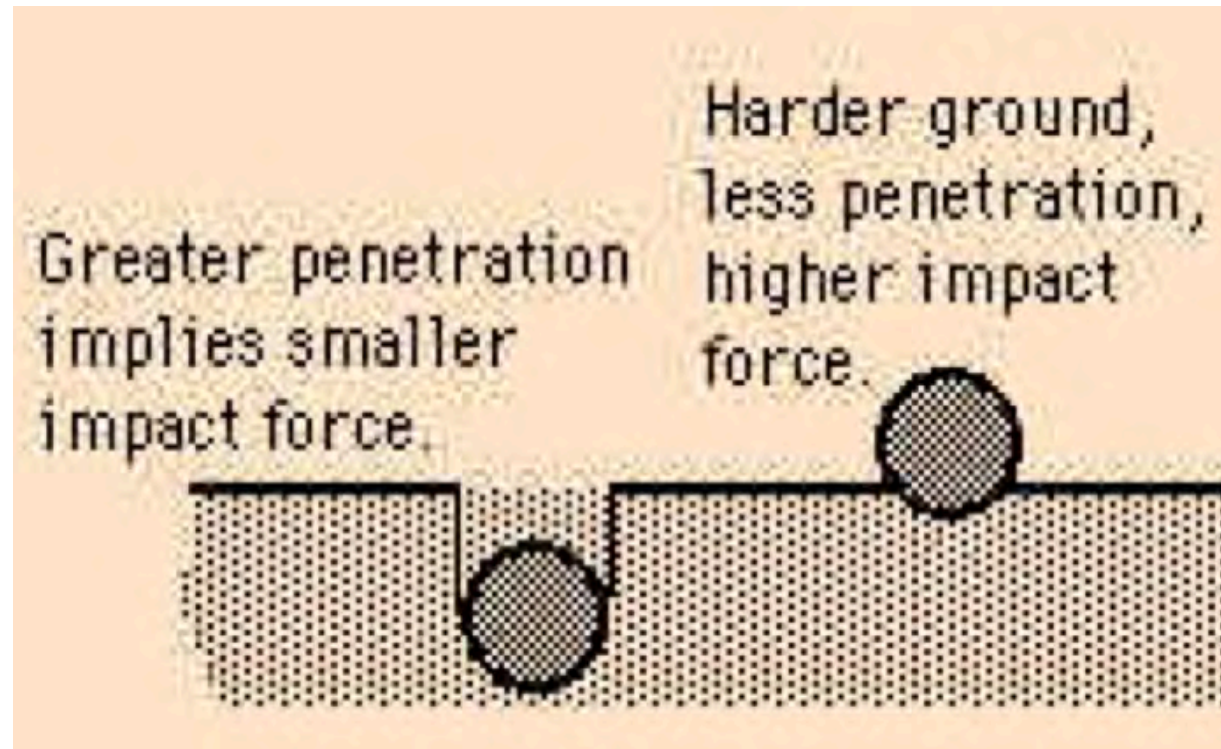
FORCE vs DEFORMATION



Wentworth Park 'wet' sand surface (typical race preparation)

400 mm, 450 mm and 500 mm drop height

FORCE vs DEFORMATION



Sphere falling onto track surface

■ SAND PROFILE AND MOSITURE LEVEL



■ SAND PROFILE AND MOSITURE LEVEL

Many different types of sand exist

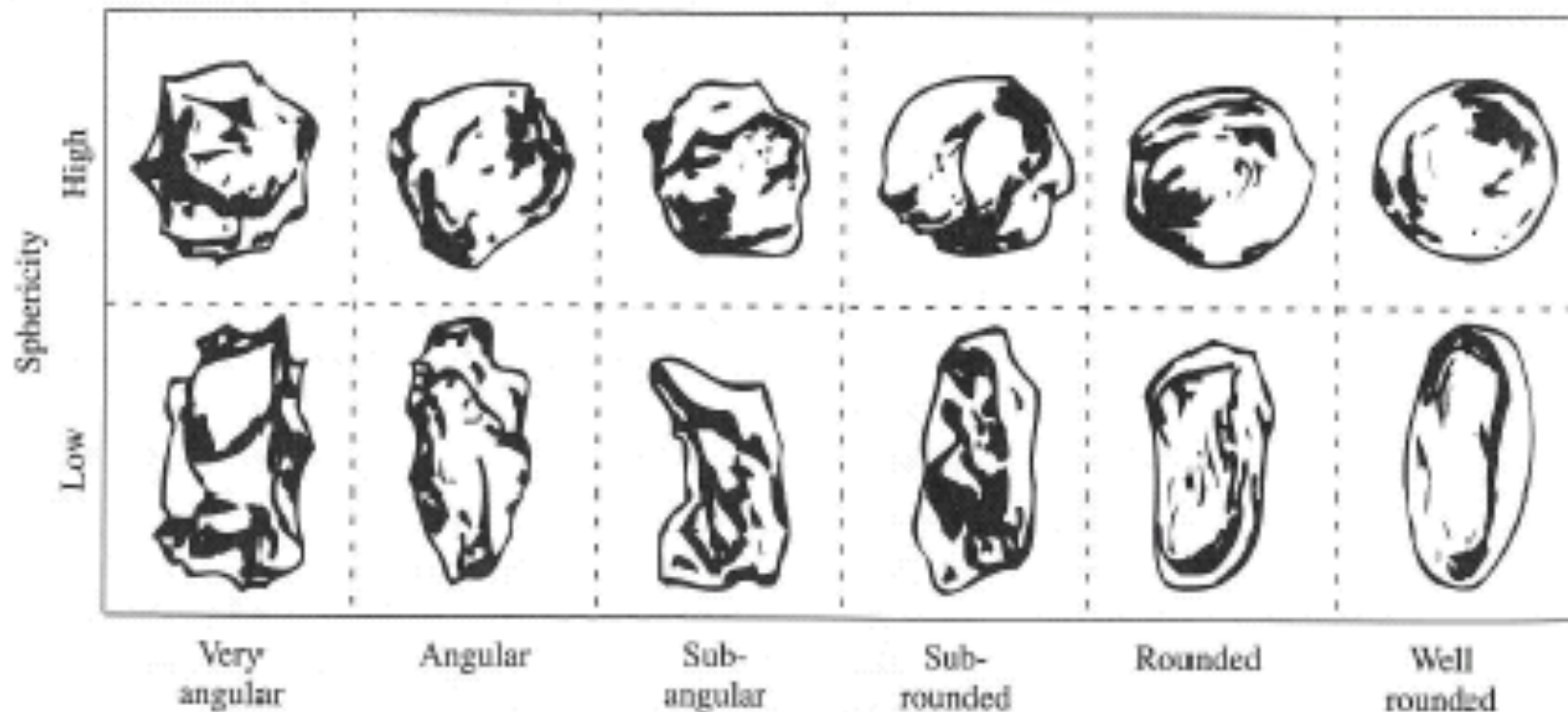
They are not all suitable for use on greyhound tracks



■ SAND PROFILE AND MOSITURE LEVEL

Particle shape – roundness and sphericity are important

- Angular particles compact and bind together
- Rounded particles allow water into the voids



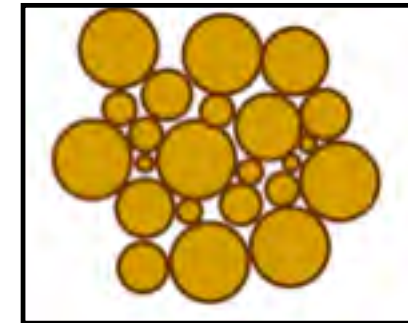
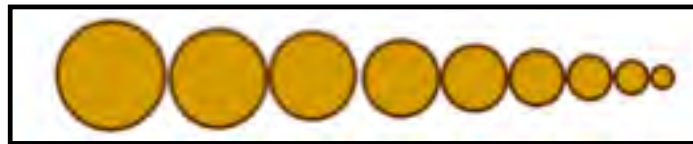
■ SAND PROFILE AND MOSITURE LEVEL

Assessment is by way of mechanical sieve analysis

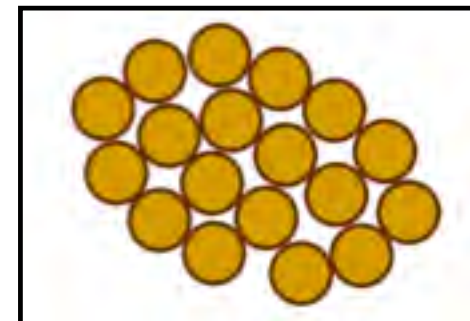
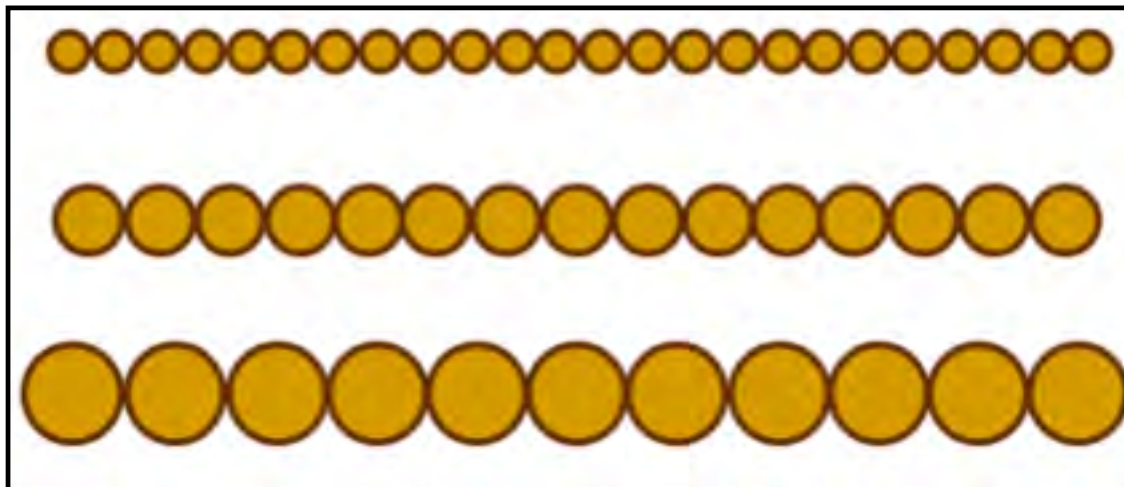


■ SAND PROFILE AND MOSITURE LEVEL

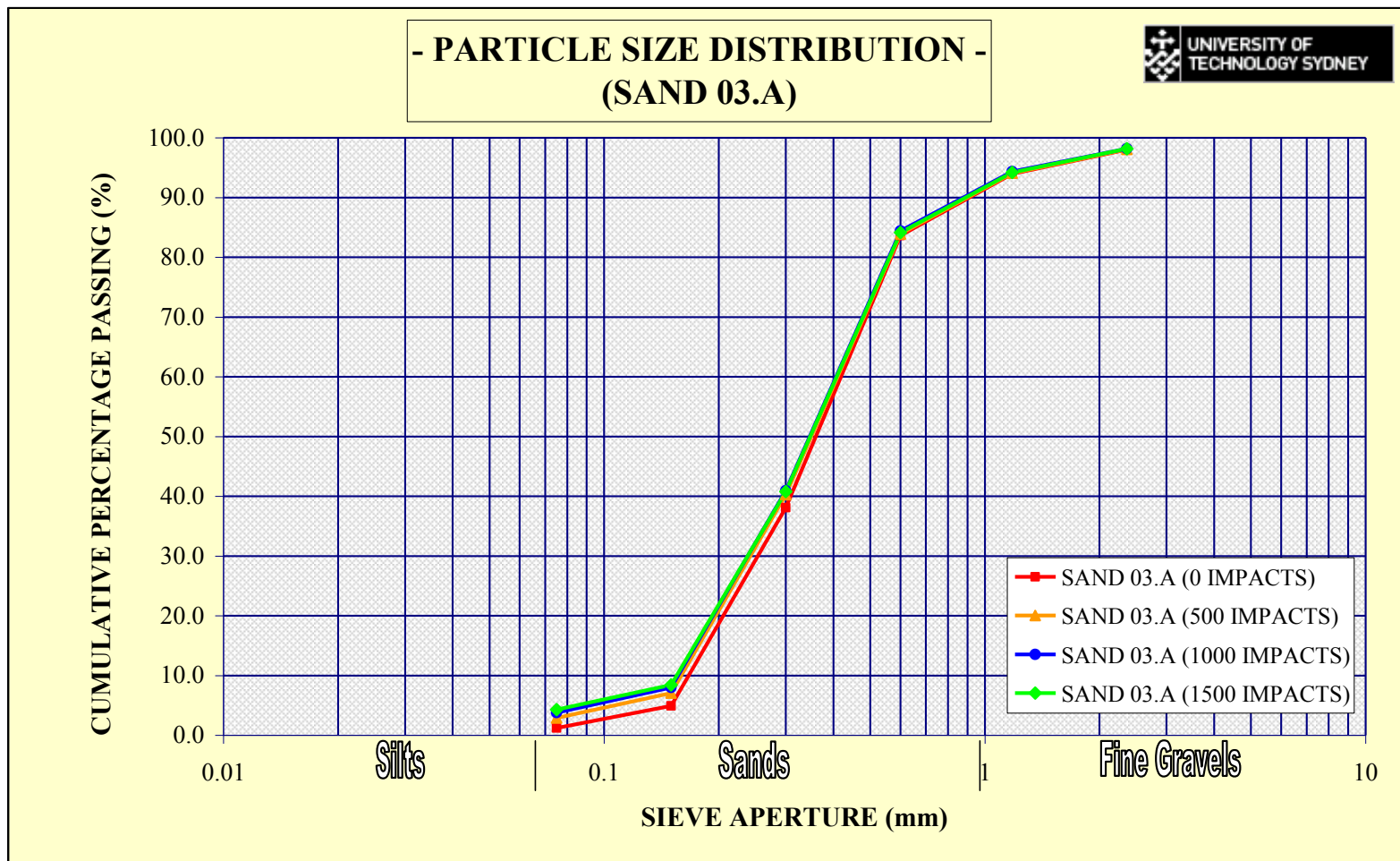
Well graded sand



Uniformly graded sand



SAND PROFILE AND MOSITURE LEVEL



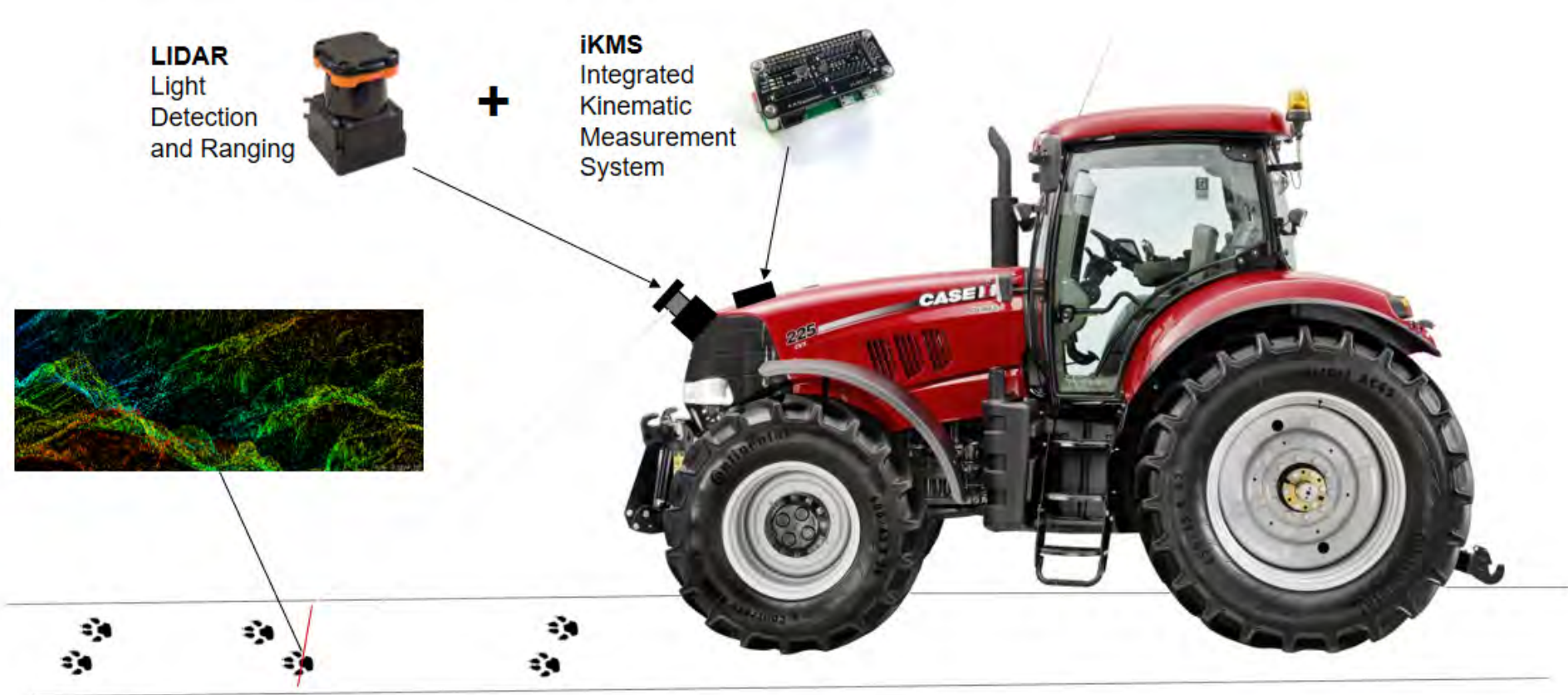
ADVANCED 3D PAW IMPRINT RECONSTRUCTION

1. Do the measured track properties capture the greyhound track racing risk factors related injuries? | **YES** | **NO**
2. Is there a correlation between recorded track properties i.e. weather, rainfall, moisture level, firmness level and injury rate (all levels)? | **YES** | **NO**
3. Do the well-established playground IAS evidence-based injury predictors convert to greyhound racing?
4. Should greyhound racing specific injury criteria be developed?
5. If so, what are they?

ADVANCED 3D PAW IMPRINT RECONSTRUCTION

1. Paw imprints can be seen as an objective measurement of track surface properties
2. It is hypothesised that optimum paw imprint will allow standardisation of current track surface analysis techniques such as penetrometer, moisture and impact testing
3. Print shape and depth may be correlated with variables such as compaction and moisture content
4. Change of surface preparation philosophy: Instead of changing variables to chase performance the greyhound racing industry chooses the performance and change the variables accordingly
5. Analysis may concluded that different surfacing properties are required where the greyhounds are subjected to different forces ie bend and straight may require different sand, moisture and/or preparation to optimise the performance
6. Additionally, paw imprint reconstruction allows analysis of previously unobtainable stride, gait and surface information

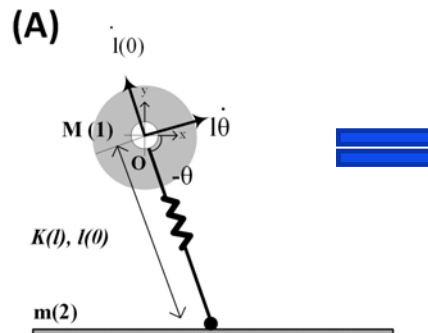
ADVANCED 3D PAW IMPRINT RECONSTRUCTION



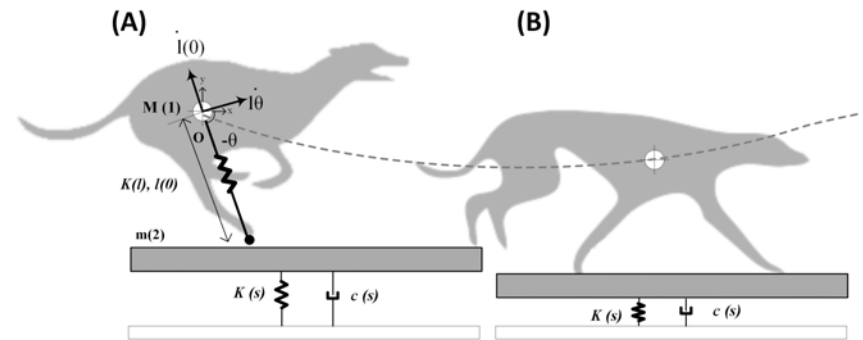
■ SIMULATION | GREYHOUNDS DYNAMICS



Clegg Hammer



Dynamic Model



Realistic models in two successive ground contacts

■ SIMULATION | TRACK FEA



Thank
You

