AUSTRALASIAN COLLEGE OF ROAD SAFETY

Pedestrian and Cyclist Safety

National Conference

9 June 2006, Transport Accident Commission, Melbourne

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Modelling the pedestrian-involved crash: case study.

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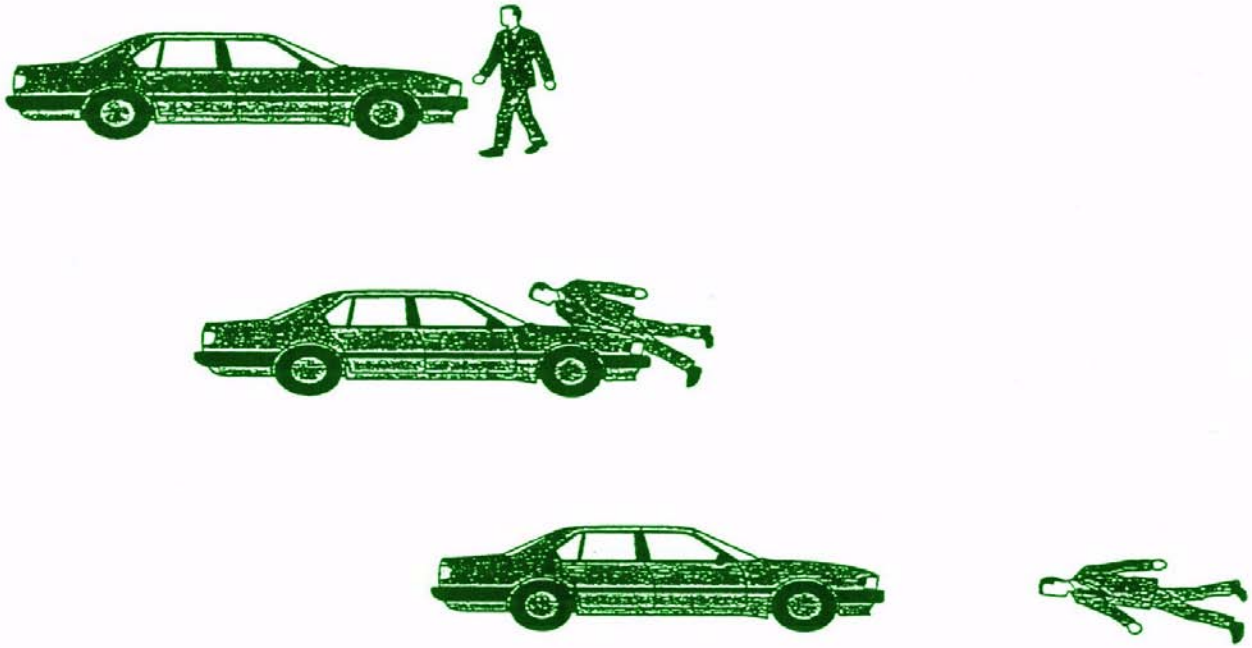
Introduction

- Most pedestrian collisions involve walking adults impacted by the front of a car.
- Collision involves the pedestrian following a ‘wrap or somersault’ trajectory.
- Body rotates upwards onto the car.
- Head will either strike the bonnet, windscreen or roof line depending on the impact speed.

The WRAP

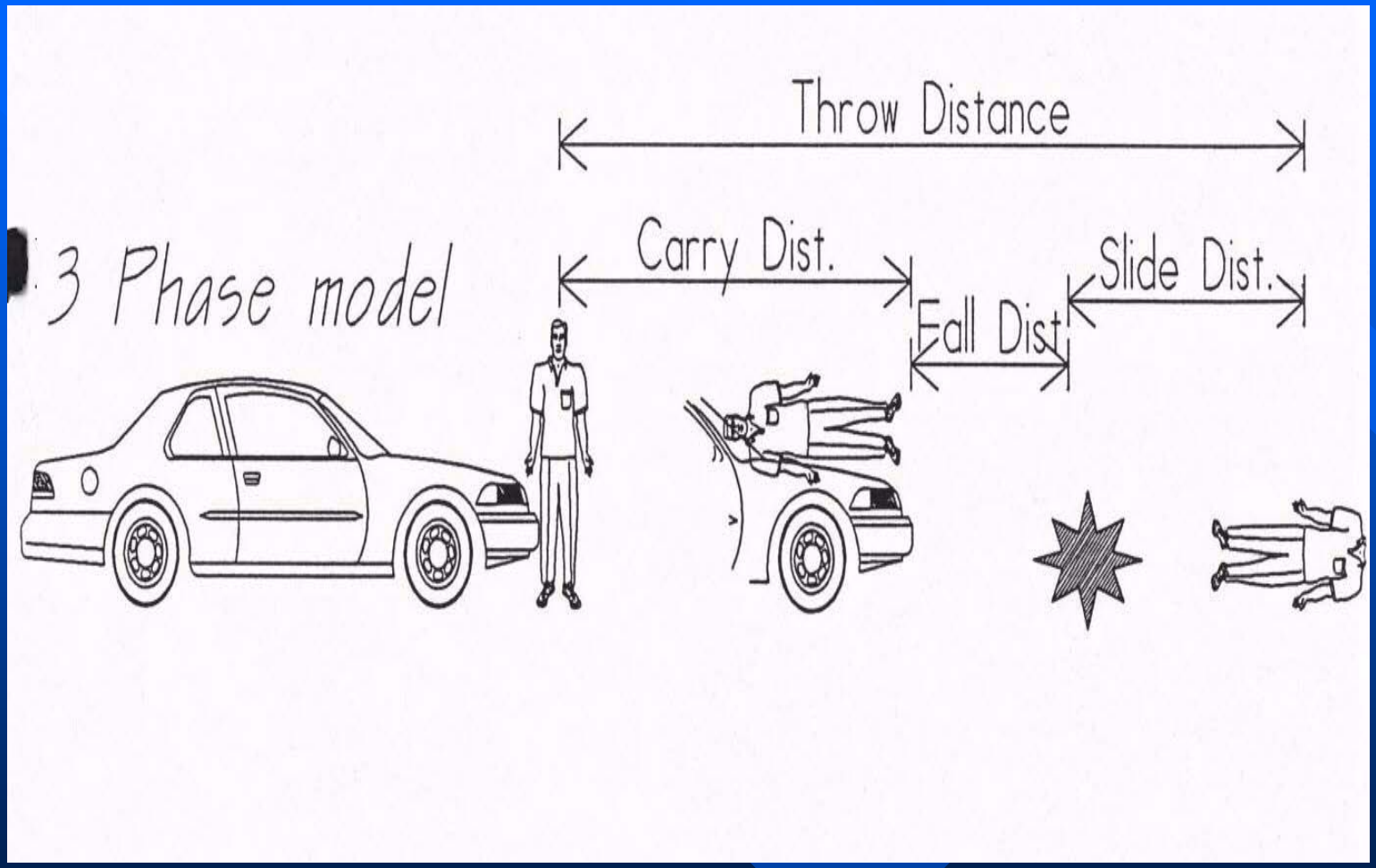


1. Most common trajectory. 80-90%

2. Impact Force is applied BELOW the ped's center of mass.

3. Striking car is usually braking.

4. Usually no windshield contact below 25 mph.


3 Phase model
Throw Distance
Carry Dist.
Fall Dist
Slide Dist.

Purpose to model the crash and replicate it with testing

- Simulations conducted 2005 in PC Crash.
- Crash Test Conducted February 2006.
- Tests b/w EL Ford sedan and pedestrian dummy 60 kg in weight and 167 cm tall.
- Speeds Estimated for impact by using throw distance evidence, head strike location.
- Results compared with simulation data.

PC Crash Simulation

- Multibody sytem to model pedestrian
- Select car from database
- Enter measurement, weight and friction data
- Assign 3D shape file for the car
- Position car, set velocity, position & sequence data
- Position multibody assign height & weight
- Set camera, run simulation and render video file.


t=0.00 s
v1=32.0 [km/h]
y
x

32 km/h impact @ 0.4 sec.

1.2 sec, head hits road

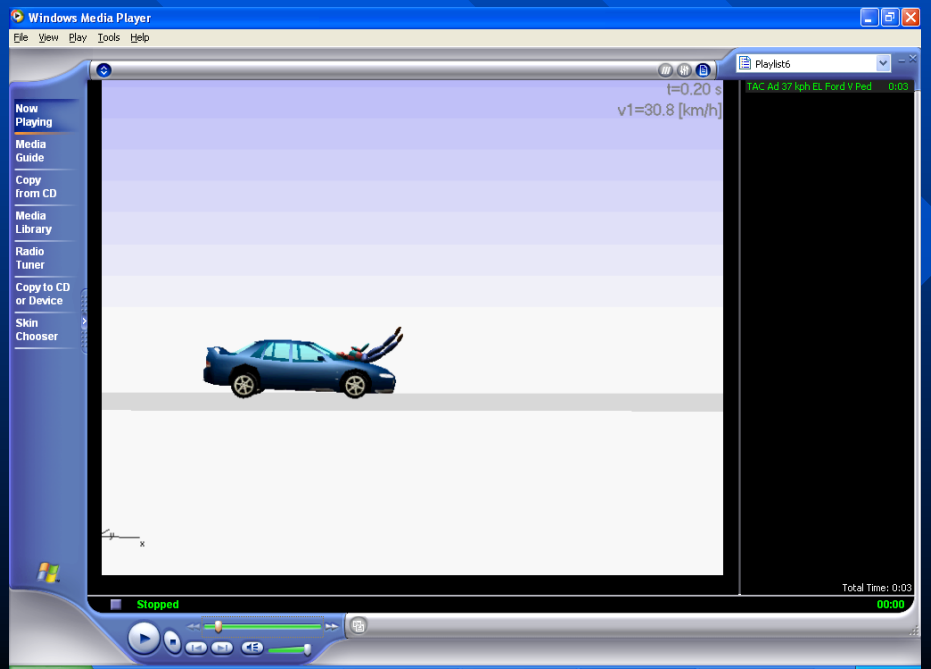
1.6 sec, car & body @ rest

32 km/h impact

- Head made contact with trailing edge of bonnet
- Previous adult pedestrian head strike research found impacts on the bonnet typically occur at speeds below 50 km/h
- Car stopped 4.72 m after impact
- Body stopped 6.8 m after impact

37 km/h impact

- Head strike on wiper arm
- Car came to rest 6.27 m after impact
- Body came to rest 10 m after impact

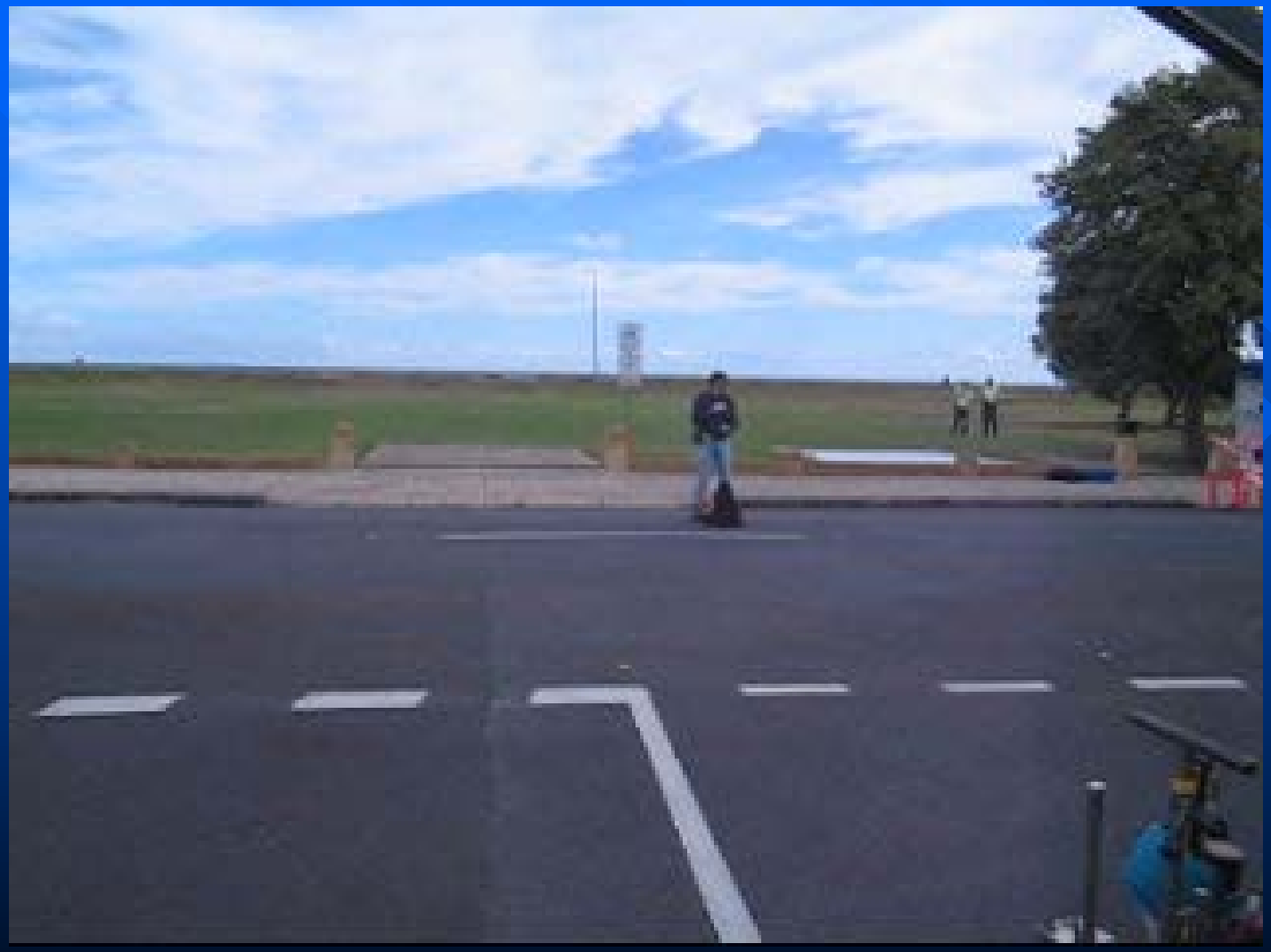


Crash Tests February 2006

- EL Ford Falcon
- Esplanade Williamstown
- Prosthetic body to replicate 60 kg, 167 cm
- Car speeds initial 65 km/h slowing down to 32 km/h at impact.

Position of pedestrian dummy prior to impact

Video of Crash Test



Video of Crash Test

Speed by Throw Distance

- Distances from Impact to Final Rest Recorded = Throw Distance (metres) = d_t.
- Searles Equations Used. SAE paper 930659. Velocities in m/sec given by...

$$V_{min} = \sqrt{\frac{2\mu g d_t}{1+\mu^2}}$$

$$V_{max} = \sqrt{2u\ g d_t}$$

In Searles' Equations

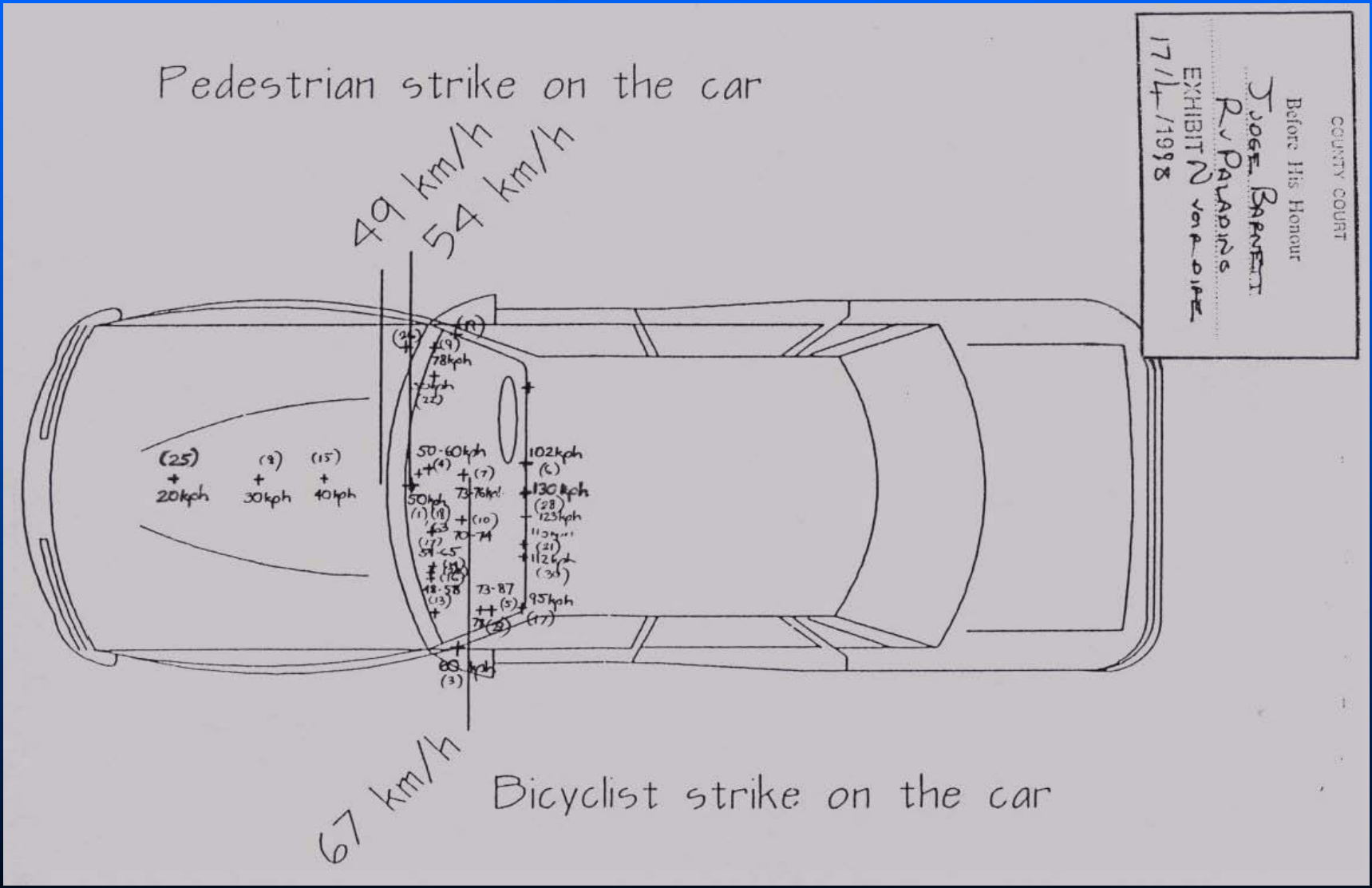
- *υ = average friction factor of pedestrian from impact to rest = 0.66 on road & 0.79 on grass.*
- *g = acceleration due to gravity = 9.81 m/s^2*
- *Velocities converted to speed by multiplying by 3.6.*
- *Average Impacting Car Speed = Min. Speed plus 20%.*

Speed by Skid Marks

- Skid distances (d) in metres from where car stopped back to location of impact and road to tyre friction (f) measured.
- Impact Speed (km/h) calculated using….

$$S = \sqrt{254df}$$

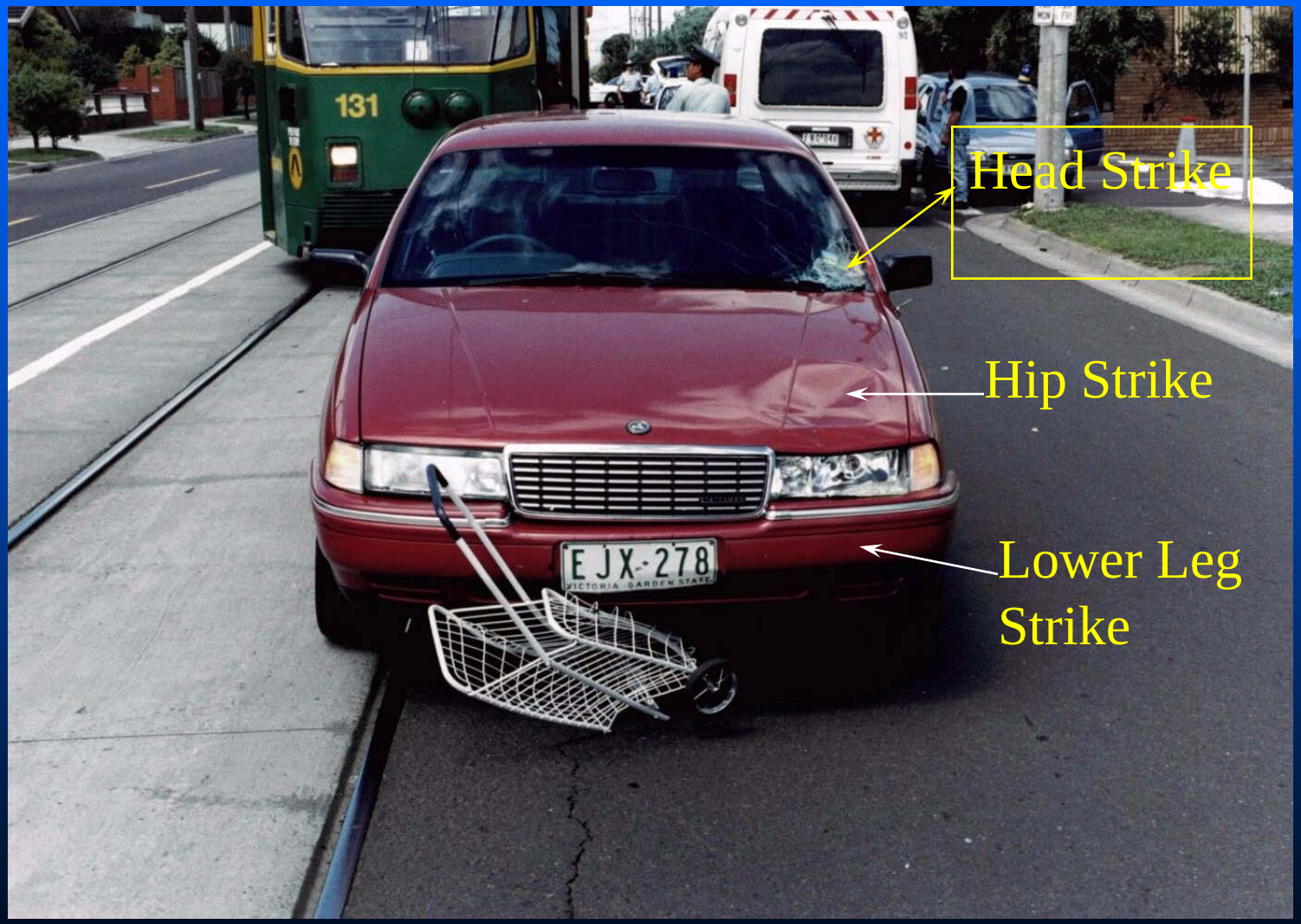
Plots of Impact Speed V Head Strike.



Speed V Head Strike

- 9% ***bonnet. 20 to 40 km/h.*** Injuries were prevalent for these collisions but ***no fatalities***.
- 41% ***bottom area of the windscreen.*** Speed range ***50 to 62 km/h***. ***All but one*** of these twelve victims received ***fatal*** injuries.
- 22% ***middle windscreen***. Speed range ***72 to 80 km/h. All fatal injuries.***
- 18% ***top windscreen or roof line***, speed range of ***95 to 130 km/h. All fatal.***

Crash 20: d_t: 26 metres = 56 kph impact. 85 y.o. male, 168 cms tall, 51 kilograms.



Crash Test Results

Test No.	Throw Dist. M	Min. Speed	Max. Speed	Av. Car Speed	Head impact damage
1	10	34kph	41kph	41kph	Bonnet
2	12	37kph	45kph	44kph	Screen
3	6	26kph	32kph	32kph	Bonnet
4	9	32kph	39kph	38kph	Wiper
5	9	32kph	39kph	38kph	Wiper

Vehicle & pedestrian dummy during head impact sequence

Rest positions of car & dummy

Damage from test 2, 44 kph

Close up of damage on wiper arm, tests 4 and 5, 32 kph to 39 kph

Wipe Off 5 Reconstruction

Conclusions

- Correlation b/w PC Crash Simulations and Crash Tests
- Consistency in multibody movement to dummy movement
- Consistency in head impact locations
- Consistency in rest positions
- Further validated Searle's equations
- Further validated PC Crash

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