ROAD TRAFFIC ACCIDENT DATA COLLECTION AND ANALYSIS WORKSHOP
COUNTRY: TAJIKISTAN

TA-6763 REG: Accelerating Innovation in Transport

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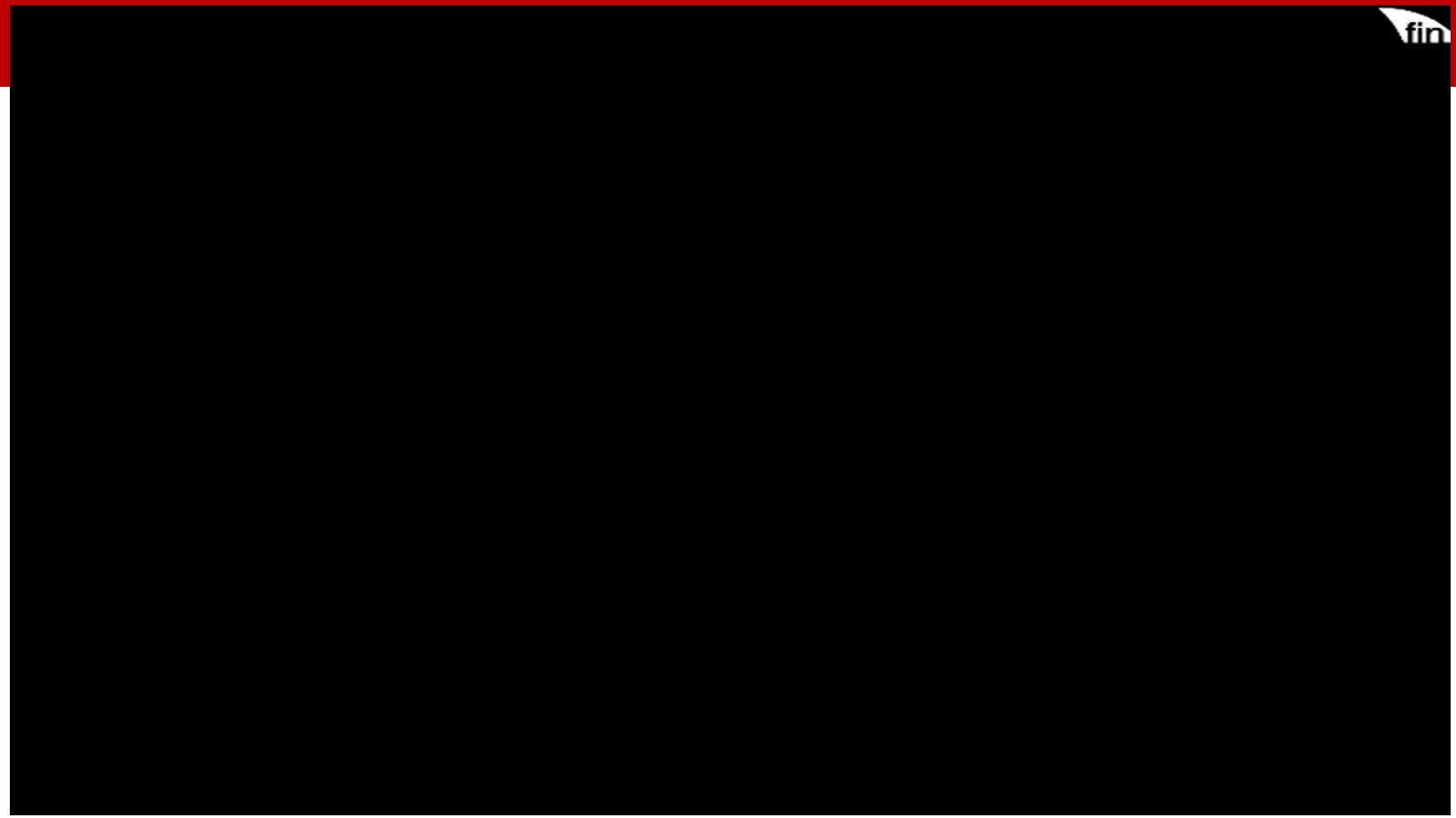
PART 4: ROAD TRAFFIC ACCIDENT RECONSTRUCTION BASICS

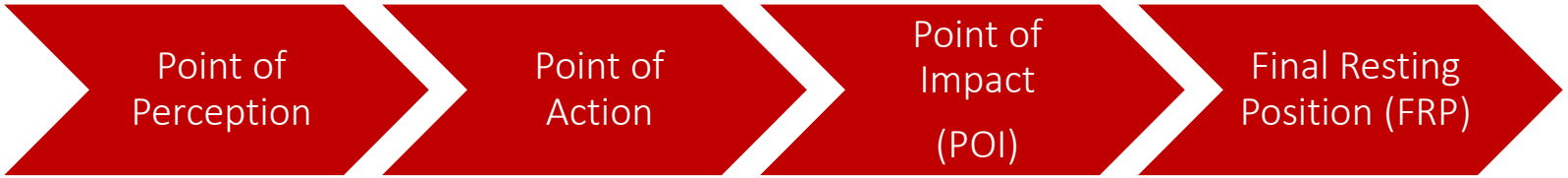
How is road traffic accident investigation data used to determine vehicle speeds?

CREATIVE VIDEO OF FORENSIC CI



Source: https://www.youtube.com/watch?v=XUXJ6ky69kI&ab_channel=RouteSafety

PHASES OF A CRASH



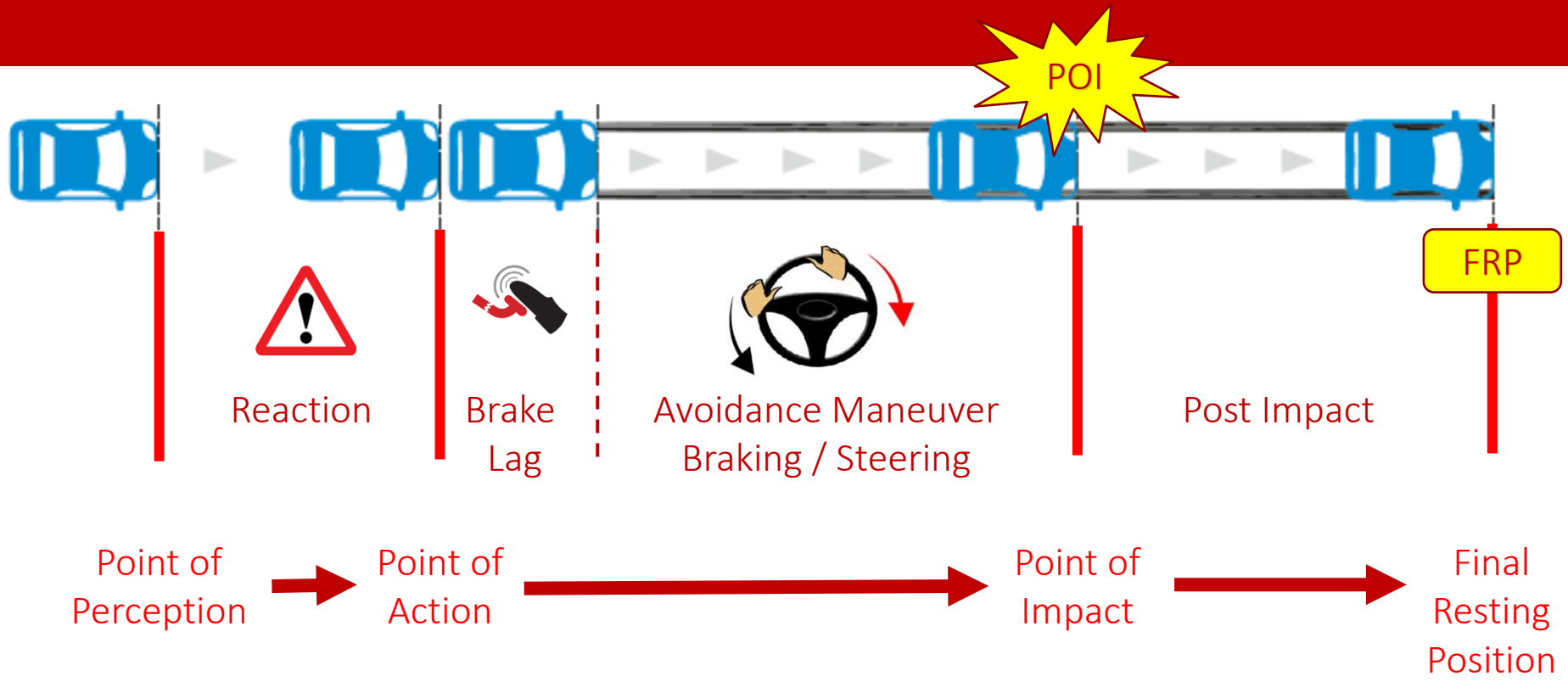
ON ARRIVAL AT A ROAD ACCIDENT SCENE…

- Which phase of the crash do you get to see?

FINAL RESTING POSITION

Assuming vehicles have not been moved after the accident.

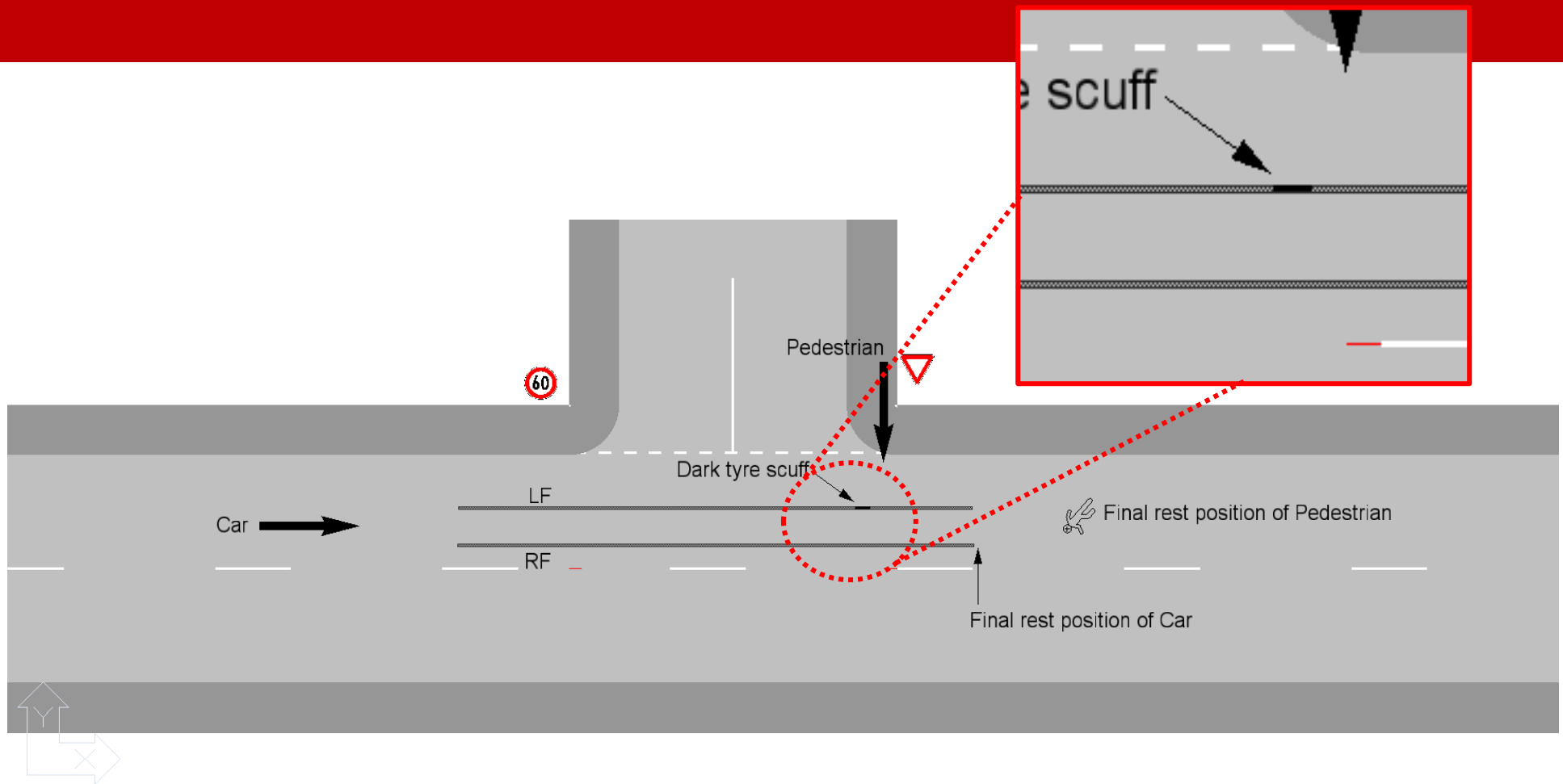
PHASES OF A CRASH



MINIMUM REQUIREMENTS FOR ACCIDENT RECONSTRUCTION

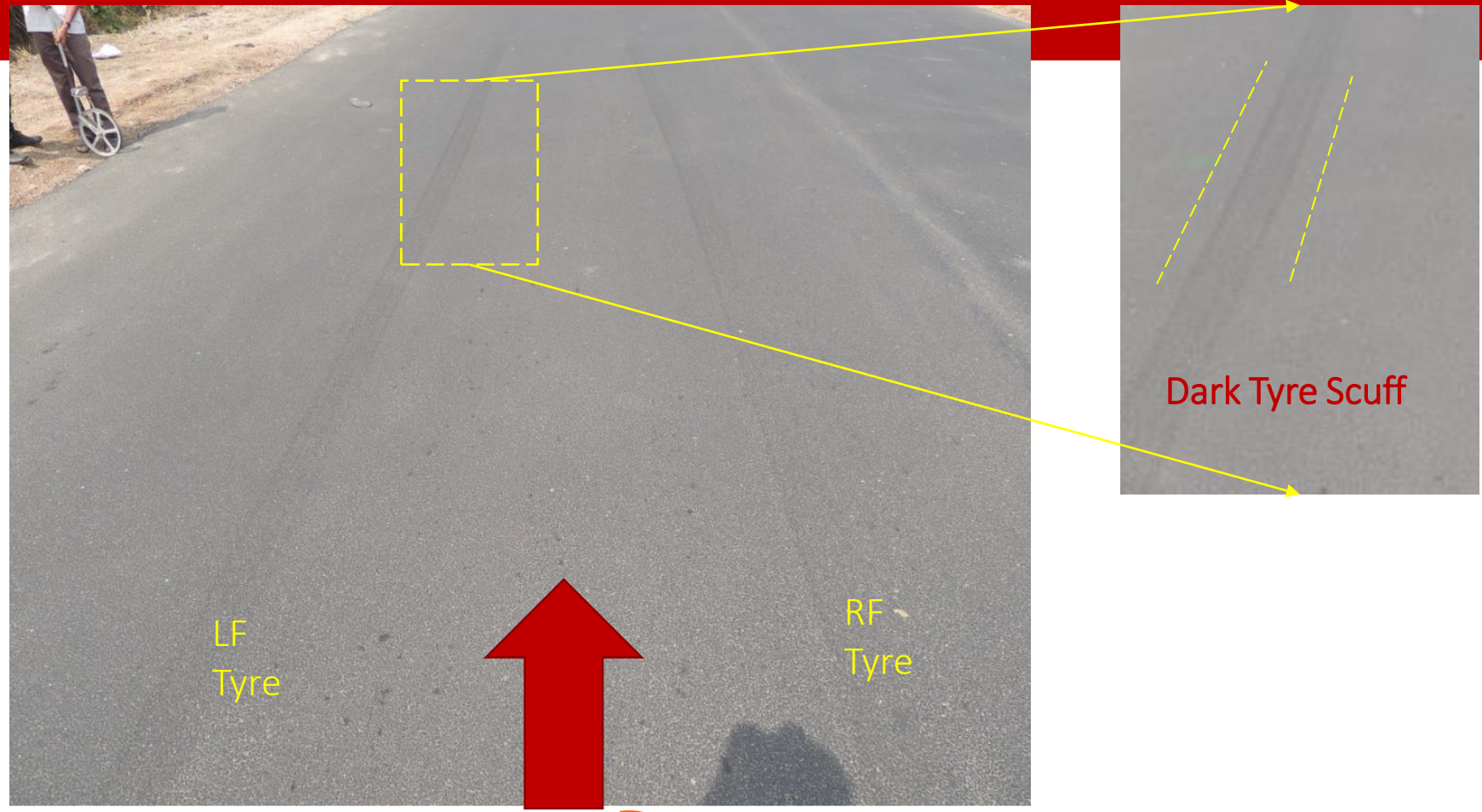
- Vehicle photos
- Scene photos
- Scene measurements
- Driver's statement
- Injury report of the victims

ANALYSING A CAR VS PEDESTRIAN ACCIDENT



PEDESTRIAN COLLISION POINT OF IMPACT DETERMINATION

PEDESTRIAN COLLISION POINT OF IMPACT DETERMINATION



UNIT CONVERSION OF SPEED

- To convert speed from kilometres per hour (kmph) to metres per second (m/s), divide the speed value by 3.6.

50 kmph ⟹ 50 / 3.6 = 13.9 m/s

- To convert speed from metres per second (m/s) back to kilometres per hour (kmph), multiply the speed value by 3.6.

13.9 *m/s* ⟹ 13.9 X 3.6 = 50 kmph

Speed in km/h	Speed in m/s
10	2.8
20	5.6
30	8.3
40	11.1
50	13.9
60	16.7
70	19.4
80	22.2
90	25.0
100	27.8
110	30.6
120	33.3

ADB

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CAREC Central Asia Regional Economic Cooperation Program

EQUATIONS OF MOTION

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Where,

v = final velocity, m/s

u = initial velocity, m/s

a = acceleration, m/s^2

t = time , s

s = distance, m

EQUATION TO BE USED

$$v^2 = u^2 + (2 * a * s)$$

v = final velocity (m/s) [at FRP = 0]

u = initial velocity (m/s) [we need to estimate]

s = distance (m) [length of brake mark]

a = acceleration/deceleration (m/s^2) [???]

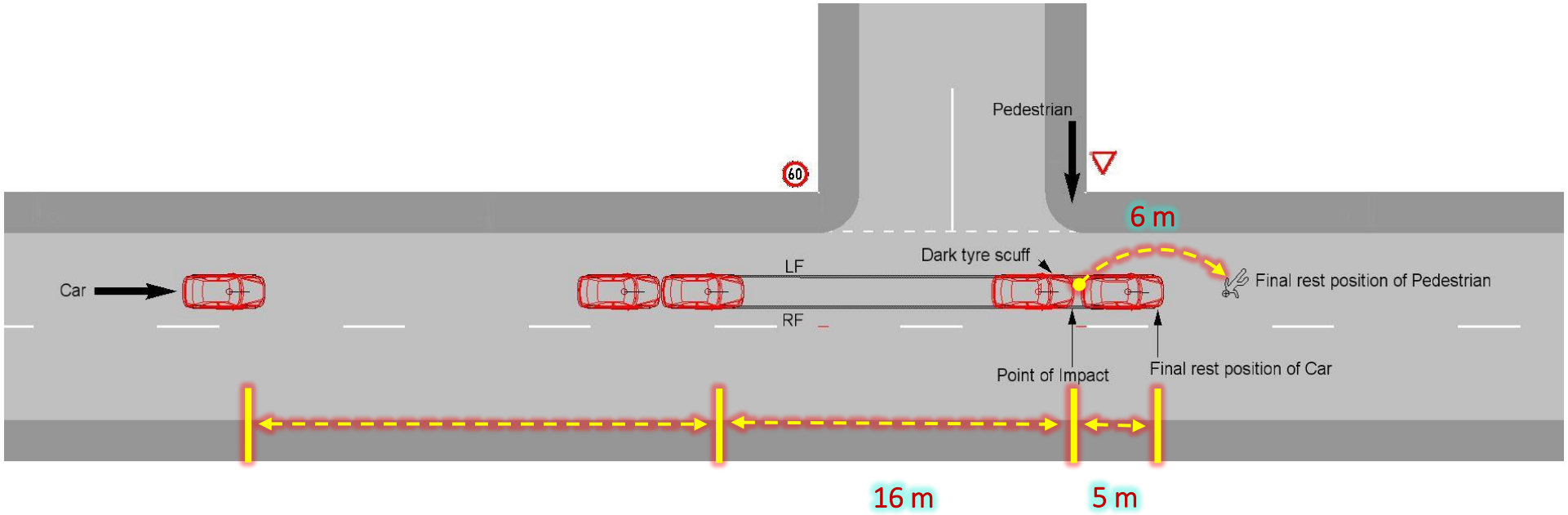
a = μ x 9.81, where μ is the coefficient of friction between tyre and road surface

COEFFICIENT OF FRICTION

- Coefficient of Friction (μ) range for a passenger car based on surface condition

Surface condition	Friction coefficient
Dry	0.70 to 0.90
Wet	0.50 to 0.70
Very wet	0.40 to 0.50
Snow	0.10 to 0.50
Ice	0.05 to 0.25

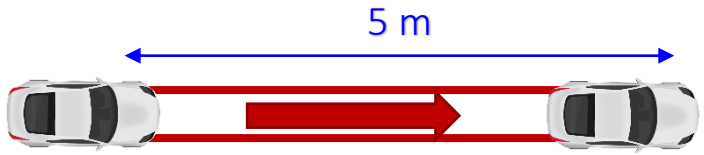
UNDERSTANDING THE SCENE EVIDENCE



For this case assuming a dry surface with $\mu = 0.8$

CALCULATION OF POST-IMPACT SPEED

- Formula used to calculate the speed of the vehicle from the available brake mark is as follows,



- $\boldsymbol{v^2 = u^2 + (2 \times a \times s)}$
- $(0)^2 = u^2 + (2 \times -7.85 \times 5)$
- $u^2 = 78.5$
- $u = 8.86$ *m/s*
- $u = 31.90$ *km/h*

u = Speed of the vehicle before braking = ?
v = final velocity = 0 m/s
a = Deceleration rate = -7.85 m/s^2 average value for full braking
s = brake mark length = 5 m ;
put these values in formula

LAW OF CONSERVATION OF ENERGY

- Kinetic energy before impact

  = Kinetic energy after impact

  + Energy lost during deformation.

Energy lost during deformation = ½ x m x $(EES)^2$

EES = Energy Equivalent Speed.

Therefore, $(\text{Pre-Impact Speed})^2 = (\text{Post-Impact Speed})^2 + EES^2$

APPLYING LAW OF CONSERVATION OF ENERGY

Post-Impact Speed = 31.90 km/h

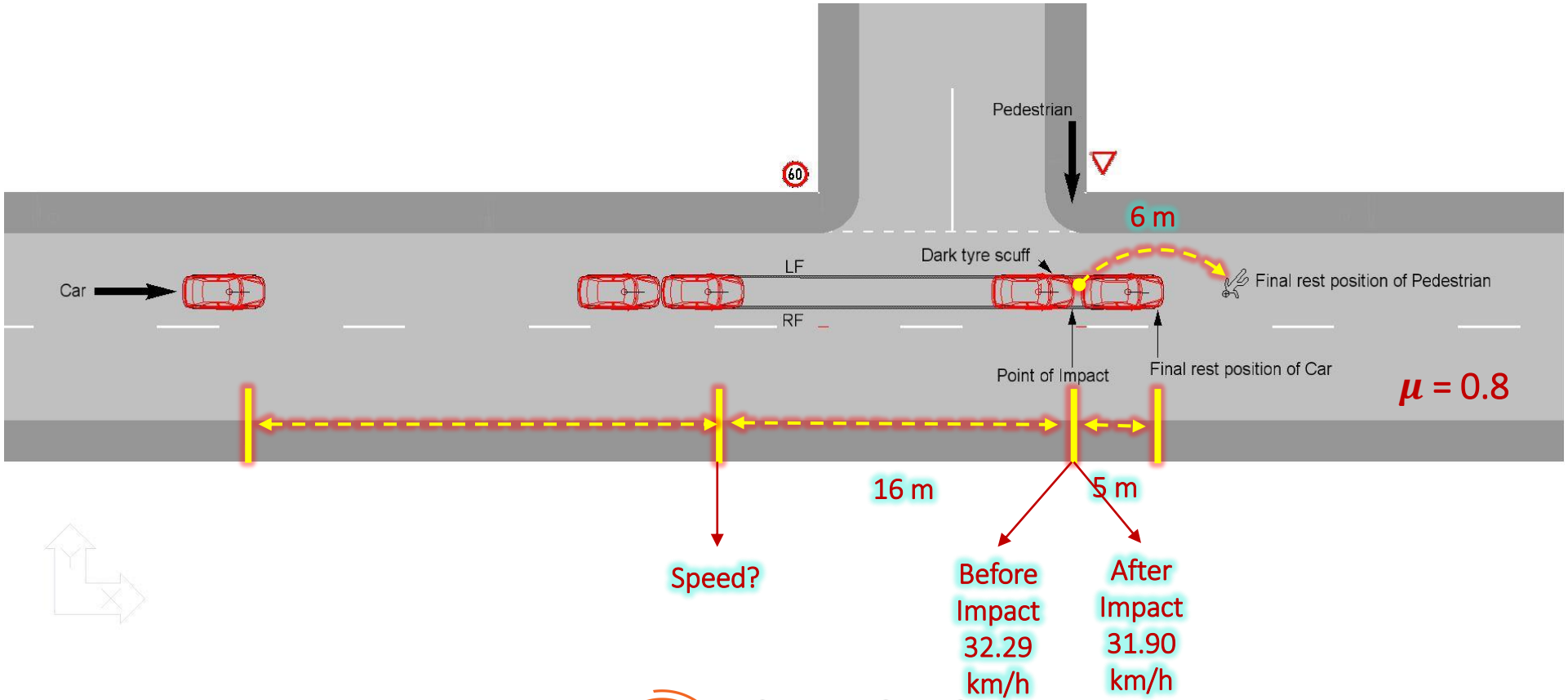
EES = 5 km/h (estimated based on vehicle damage)

$\frac{1}{2} * m_{car} * (\text{Pre-Impact Speed})^2 = \frac{1}{2} * m_{car} * (\text{Post-Impact Speed})^2 + \frac{1}{2} * m_{car} * EES^2$

$(\text{Pre-Impact Speed})^2 = (31.90)^2 + (5)^2 = 1042.61$

Pre-Impact Speed = 32.29 km/h (8.97 m/s)

CALCULATING SPEED AT START OF BRAKE MARK



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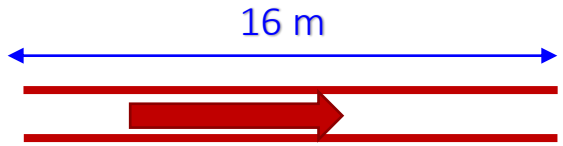
CALCULATING SPEED AT START OF BRAKE MARK

- Formula used to calculate the speed of the vehicle from the available brake mark is as follows,



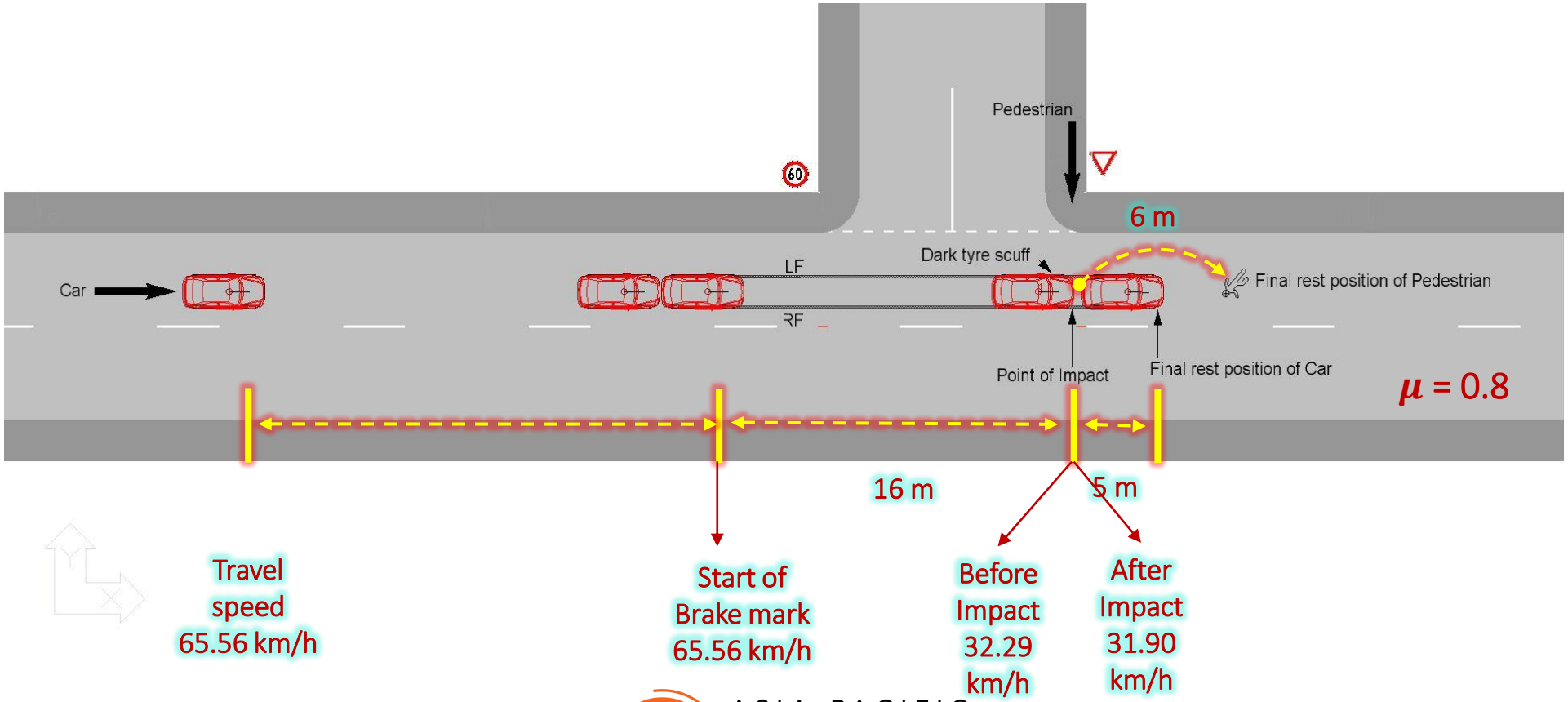
- $v^2 = u^2 + (2 \times a \times s)$
- $(8.97)^2 = u^2 + (2 \times -7.85 \times 16)$
- $u^2 = 80.46 + 251.2$
- $u = 18.21$ *m/s*
- $u = 65.56$ *km/h*

u = Initial Speed = ?
v = Final Speed = 8.97 m/s

a *= Deceleration rate = -7.85* m/s^2
average value for full braking

s *= brake mark length = 16 m ;*
put these values in formula

CALCULATING SPEED AT START OF BRAKE MARK



SUMMARY OF CALCULATIONS

Calculations	Values	Speeds (kph)
Calculating post impact speed, $\boldsymbol{U = \sqrt{[(V_0^2 - (2\ x\ a\ x\ s_0)]}}$ $\boldsymbol{s_0}$ - Post impact distance a - μ x g (friction coefficient x acceleration due to gravity) V_0 - Final speed, here, '0' as the vehicle comes to stop	s_0 = 5 m a = -7.85 m/s^2	31.90 (8.86 m/s)
Calculating pre impact speed, $\boldsymbol{V_1 = \sqrt{(U^2 + EES^2)}}$ U_0 - Post impact speed EES - Equivalent Energy Speed (researcher estimation)	EES = 5 kmph	32.29 (8.97 m/s)
Speed at start of tire marks, $\boldsymbol{V_2 = \sqrt{[V_1^2 - (2\ x\ a_b\ x\ s_1)]}}$ V_1 - Pre impact speed a_b- Maximum acceleration while braking s_1- Braking distance	s_1 = 16 m a = -7.85 m/s^2	65.56 (18.21 m/s)

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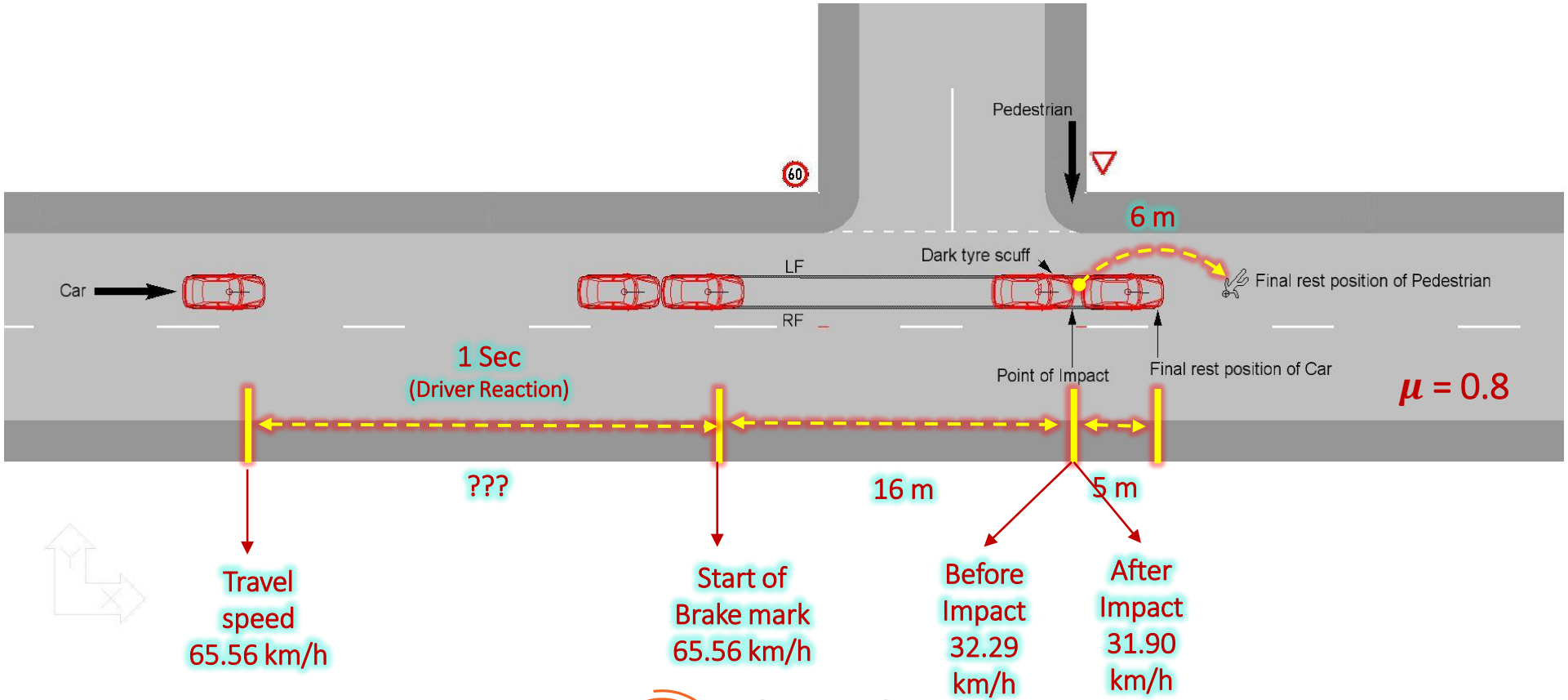
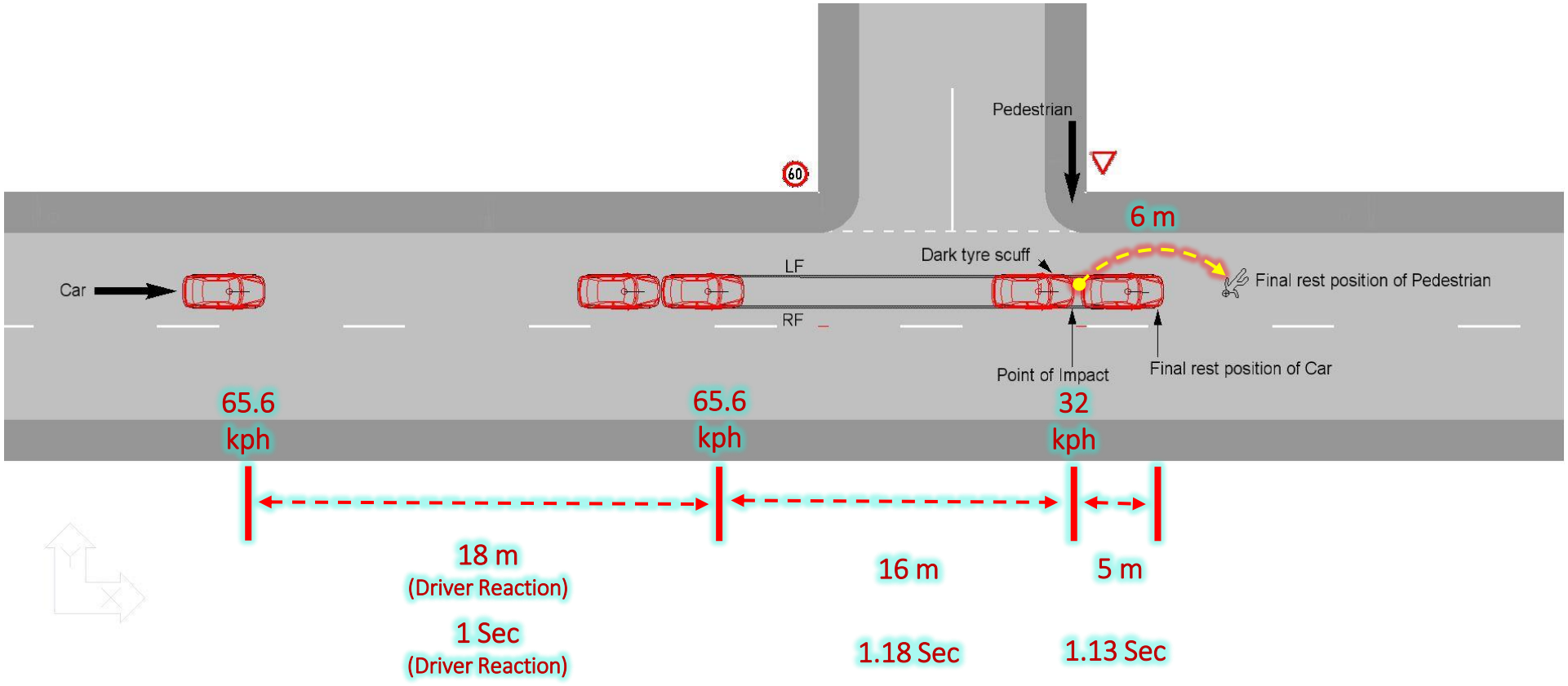
REACTION TIME

- Time required from the point of initial detection of the hazard in one's field of view,
- through various stages of evaluation and decision making,
- to the time that vehicle control components are actuated, which includes the time necessary to move hands and feet to the appropriate vehicle controls (such as movement of one's foot to the brake pedal).
- **In general, taken as 1 to 2 seconds for a sober and alert driver.**

REACTION DISTANCE?



THE CALCULATION RESULTS



RECON VIDEO - 1X SPEED

NOW WATCH THIS AGAIN.

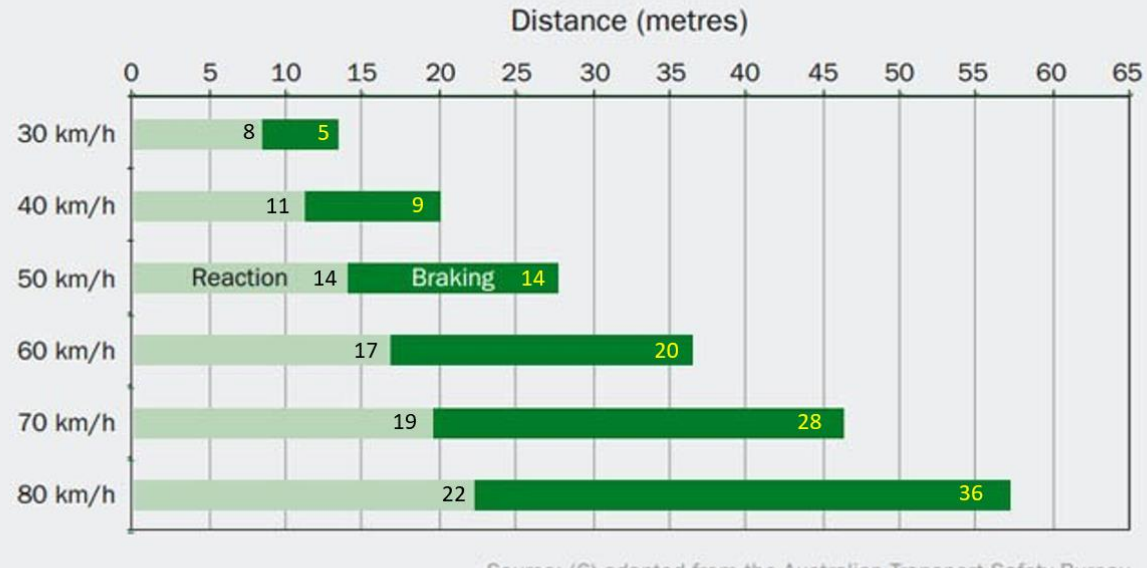
Source: https://www.youtube.com/watch?v=XUXJ6kyGkI8&ab_channel=CourseSafety

IF CAR TRAVEL SPEED IS 60 KM/H? WHAT WOULD HAPPEN TO THE PEDESTRIAN?

Source: https://www.youtube.com/watch?v=XUXIGkyS0k8&ab_channel=RoadSafety

STOPPING DISTANCE:
DISTANCE TRAVELLED DURING REACTION TIME AND BRAKING

Figure 1.2 Illustration of the stopping distance in an emergency braking



Source: (6) adapted from the Australian Transport Safety Bureau

PART 4:
ROAD TRAFFIC ACCIDENT RECONSTRUCTION BASICS

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