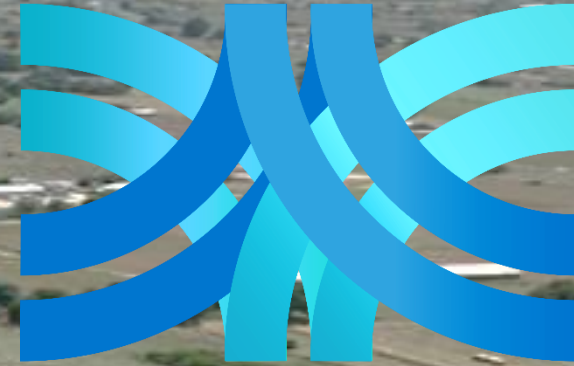


**MULTIPLE VEHICLE COLLISIONS
ON MOTORWAYS:
CAUSES, MEASURES AND REMEDIES**

ASECAP DAYS



COSTA NAVARINO 2019

47TH ASECAP STUDY & INFORMATION DAYS

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Dr. Ing.Professor AUTH***



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1. SAFETY ON MOTORWAYS



- ✓ Motorways respond to high safety and serviceability standards
- ✓ Motorways are by far the safest road network

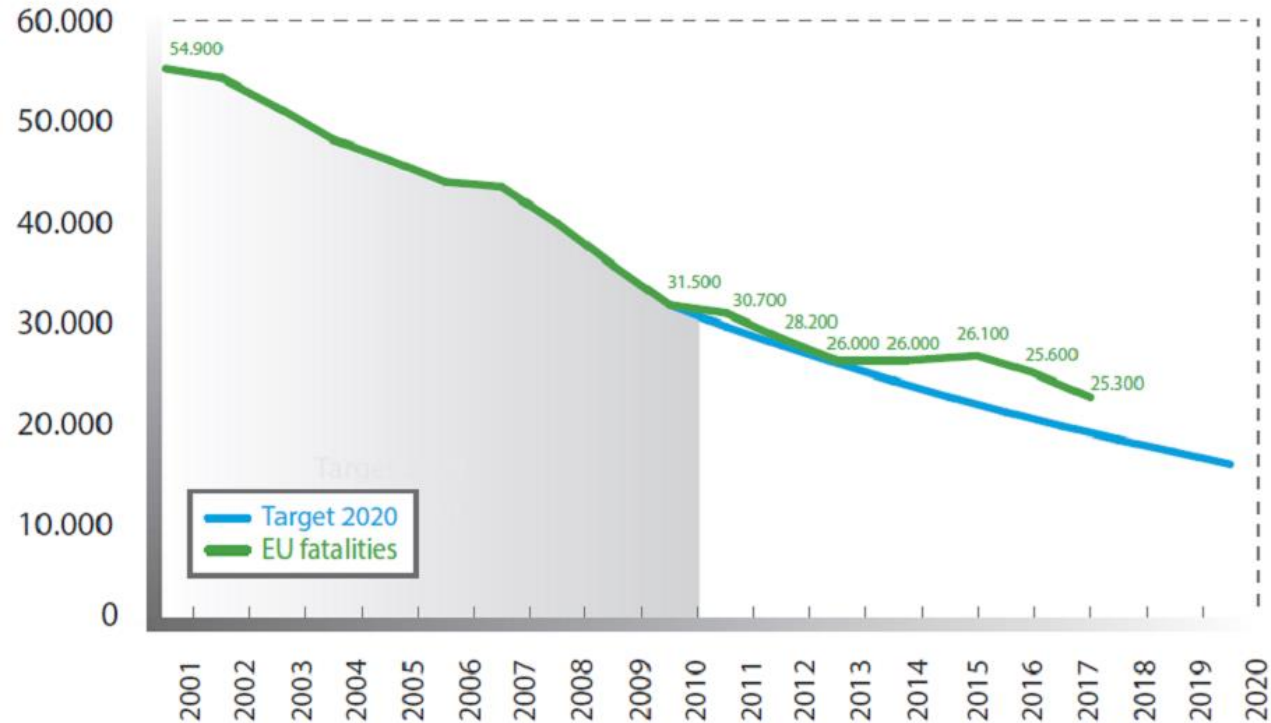
1. SAFETY ON MOTORWAYS



- ✓ However, traffic accidents occur
- ✓ Causes: Distraction, Excessive speed, Defective vehicle, Road deficiencies



1. SAFETY ON MOTORWAYS: FIGURES /ROAD ACCIDENTS



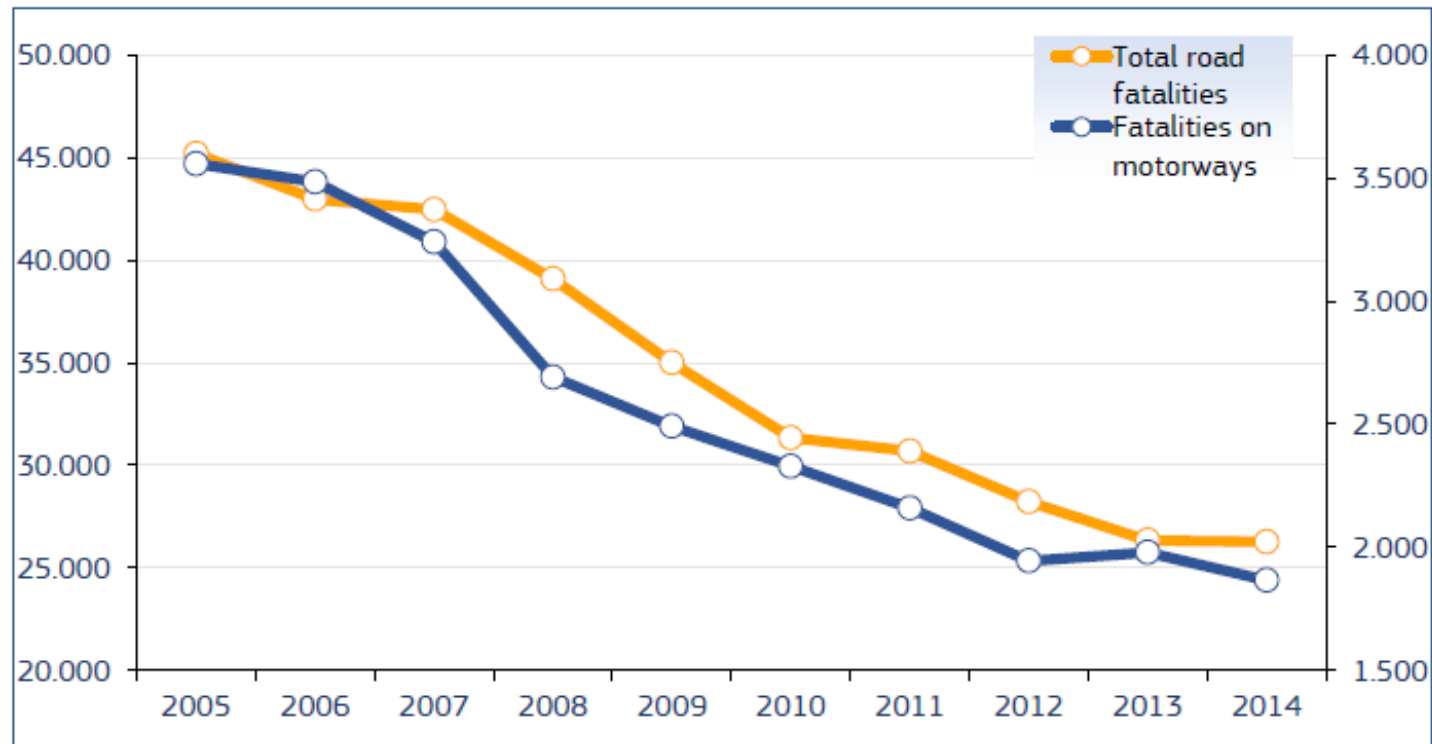
Source – CARE (EU road accidents database)

- ✓ Road accidents and fatalities in EU
- ✓ European roads: The safest in the world

EU: 50 fat./10⁶ h World: 170 fat./10⁶ h

1. SAFETY ON MOTORWAYS: ACCIDENTS IN EU

Number of fatalities on motorways and all road fatalities, EU, 2005-2014



Source: CARE database, data available in May 2016

Accident rate on motorways : $1-2/10^6$ veh X km

1. SAFETY ON MOTORWAYS: MULTIPLE VEHICLE COLLISIONS



- ✓ A most disastrous incident on motorways: the multiple-vehicle collision
- ✓ MVC : A road traffic accident involving many vehicles

1. SAFETY ON MOTORWAYS: MVC MECHANISM

Triggering mechanisms of Multiple Vehicle Collisions

Unexpected condition/obstacle → Loss of vehicle control

→ 1st crash and road blockage → Multiple crashes



2. MVC: MAIN CAUSES



Low visibility: Thick fog, smog, heavy rainstorm, snowstorm

2. MVC: MAIN CAUSES



Driver's: Distraction, dizziness, clumsy maneuvering, inconsiderate driving

2. MVC: MAIN CAUSES



Pavement : Thick water film, snow, ice, black ice

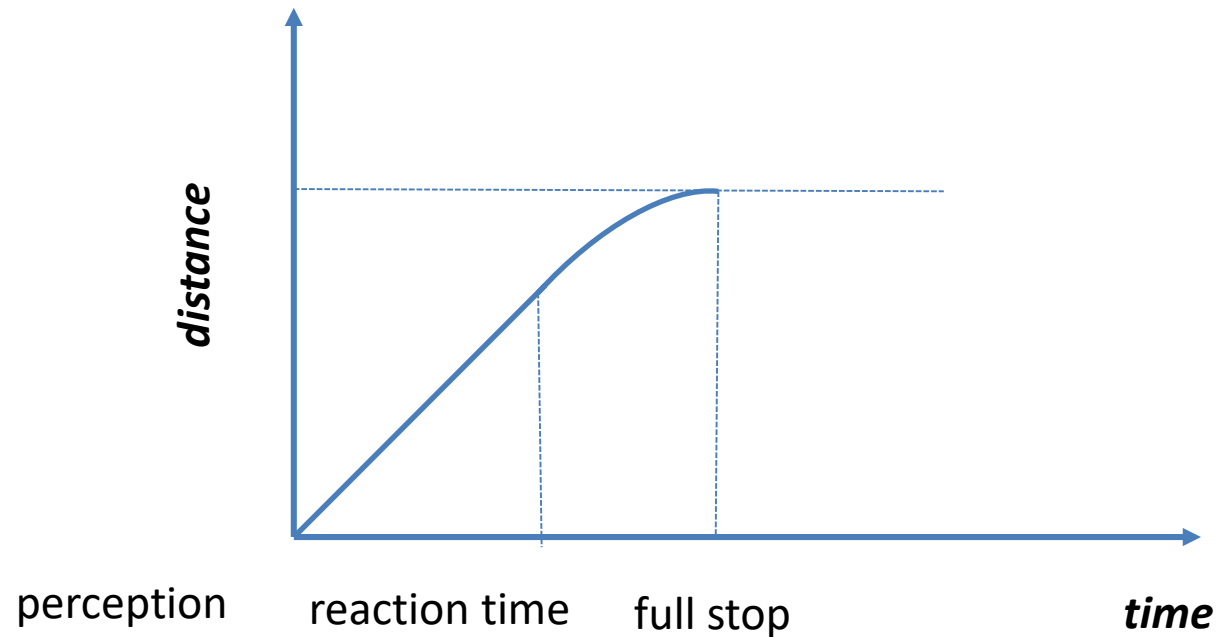
2. MVC: MAIN CAUSES



Unexpected obstacle : Rockfall, closure, animal, stopped vehicle



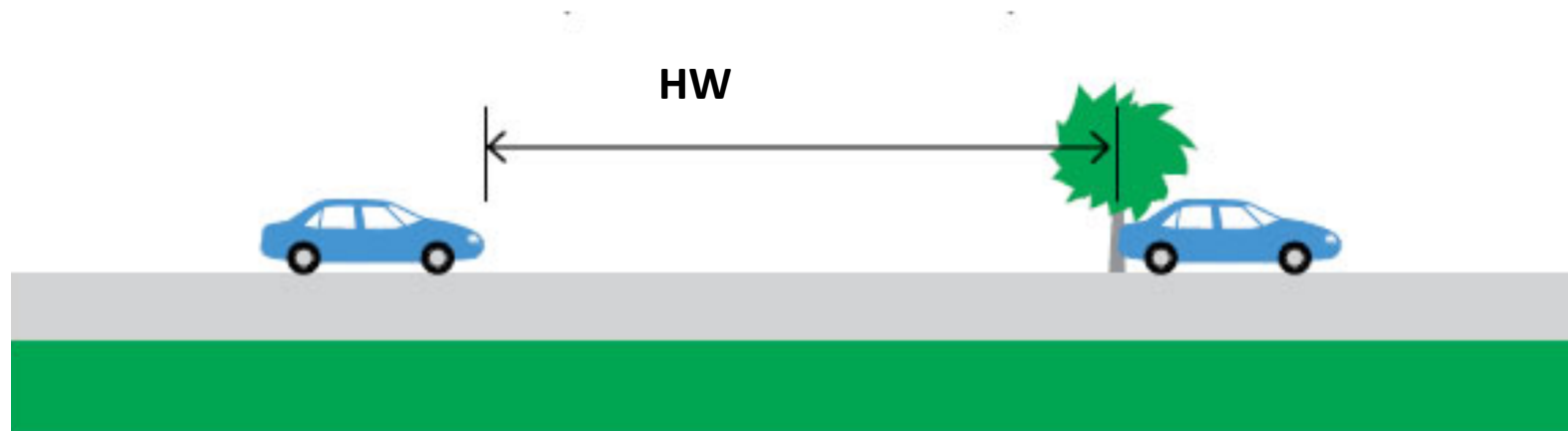
3. DYNAMICS OF MOTION



$$S (\text{Distance}) = V_o \cdot t + V_o^2 / 2a$$

a = coefficient of deceleration

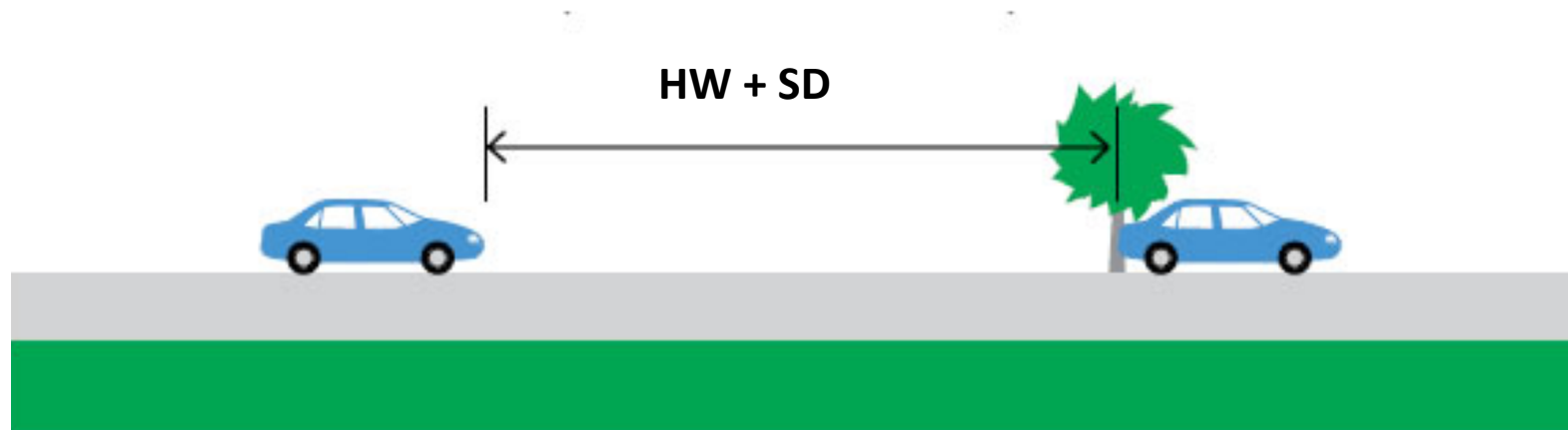
3. DYNAMICS OF MOTION



In ordinary conditions, you only need the headway of 2 seconds (2,5 sec.)

The car in front may slow down but it will not stop / be completely immobilized

3. DYNAMICS OF MOTION



In fog, heavy snow, storm, low visibility conditions, the car in front may not be clearly seen. Driver may suddenly discern/perceive an immobile object / car.

The headway of 2 seconds is not sufficient.

4. AUTH RESEARCH ON PILE-UP ACCIDENTS

Analysis of 50 major pile-up accidents 1989-2019

- ✓ **Road features** : alignment and number of lanes
- ✓ **Crash figures** : number of vehicles /duration/injuries
- ✓ **Causes** : triggering / secondary



4. AUTH RESEARCH ON PILE-UP ACCIDENTS

Analysis of 50 major pile-up accidents 1989-2019

✓ **Road features:** Motorways 2x2, 2x3, 2x4

Traffic volume: ADT=20,000-100,000

Alignment : straight (25), wavy (20)

Speed limit : 70-130 km/h

4. AUTH RESEARCH ON PILE-UP ACCIDENTS

Analysis of 50 major pile-up accidents 1989-2019

- ✓ ***Crash figures:*** Fatalities: 1-50
per accident
 - Injuries: 10-100
 - Number of vehicles: 20-200
 - Probability of occurrence: low
 - Risk: high

4. AUTH RESEARCH ON PILE-UP ACCIDENTS

Analysis of 50 major pile-up accidents 1989-2019

✓ ***Probable causes:***

- Triggering: Thick fog (30)
Rainstorm, snowstorm, blinding sun
Icy road
Inconsiderate driving
- Secondary: High speed
Driving errors
Tailgating
Road works

5. MVC: THE MEASURES ON MOTORWAYS

A. THE PREREQUISITES

- ✓ Traffic surveillance
- ✓ Weather forecast and monitoring
- ✓ Pavement condition monitoring
- ✓ VMS Panels before interchanges



5. MVC: THE MEASURES ON MOTORWAYS



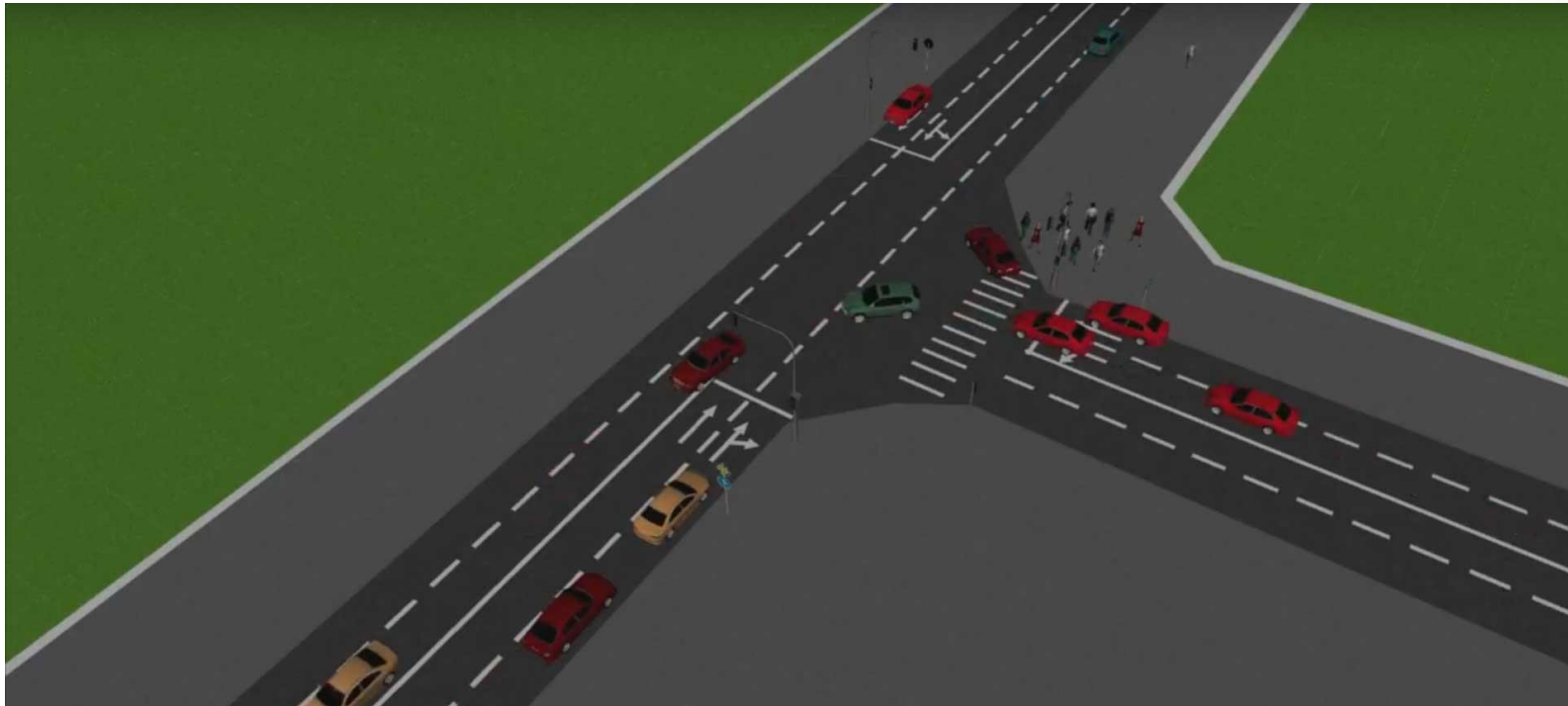
- ❖ Install and operate hazard lights / warning signals at high risk conditions

5. MVC: THE MEASURES ON MOTORWAYS



- ❖ Emergency patrols, Info (radio, toll stations, VMS), enforcement, snow/low readiness

5. MVC: THE MEASURES ON MOTORWAYS



❖ The real-time prediction / prevention models

6. THE REMEDIES: Effective traffic incident management



6. THE REMEDIES: traffic incident management

a. Detection and early warning : CCTV, Emergency calls, Unmanned aerial vehicle , VMS panels, radio information, connected vehicles



6. THE REMEDIES: traffic incident management

b. Response, on-scene traffic control and evacuation: emergency plan, training, uniform management and task allocation, new agile towing vehicles, medical services, helicopters.



6. THE REMEDIES: traffic incident management



c. Debris removal, restore traffic flow, infrastructure upgrading



6. THE REMEDIES: Effective traffic incident management

1. Speedy detection and response
2. Good information about location, severity and any attendant hazards
3. Protection of the scene and ensuring safety of responders, victims and the public
4. Coordinated response with a clear structure of authority, roles and responsibility
5. Reliable communications between responders and the public
6. Provision of appropriate equipment, facilities, access paths and control centers
7. Sufficient backup services to ensure speedy clearance to minimize congestion
8. Training and debriefing systems
9. Written guidelines and formal agreements where necessary
10. Monitoring, performance assessment and feedback into practice

7. CONCLUSIONS

- ✓ Multiple vehicle collisions on motorways are disastrous. They occur rarely but their consequences are severe
- ✓ Low visibility is the main triggering factor for MVC. Slippery pavement and inconsiderate driving contribute to MVC.
- ✓ Proactive measures are recommended to prevent MVC. Real-time safety prediction models seem to be most effective innovative tools.
- ✓ Well-planned traffic incident management and adequately trained personnel will prevent secondary crashes, congestion, unpleasant/despairing situations and save lives

Thank you !!

