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The prevention and collision analysis between a cyclist and vehicle door

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Abstract: *The following study analyzes the severity of injuries suffered by a cyclist hitting a fast-oncoming obstacle such as a vehicle door. In order to have some realistic results, 2 experiments were made. The first experiment was effectuated by measuring the time needed for the rider to avoid the collision by steering. Then the second experiment was a simulation of the bicycle rider hitting the vehicle door to determine the possible injuries that may occur. Then the data was analyzed to raise attention to the severity of the collision and main causes of this kind of accident.*

Keywords: *dooring, bicycle, simulation, experiment, analyzes*

1. INTRODUCTION

The study discusses about the importance of traffic diveristy and the need to adjust the infrastructure to make transportation safer is a must. Due to byrocratic or politic issues , the traffic tends to accomodate the surroundings by adapting to the flow and driving styles wich are most frequent , but it can be more dangerous for all traffic participants.

The focus will be on the 2 wheeled self propelled or electic vehicles Eg.(bycicle , scooter , electic scooters , mopeds) that are less visible to the drivers and often they need a safe road to travel : bycicle lanes , that are less exposed to ordinary traffic and pedestrians . The implementations of a cycling lane in a crowded city or an historic city can be a challenge.

Often the cycling lanes are between the driving lanes and crosswalk or integrated in the crosswalk. The danger is when a driver is stopped and want to exit the vehicle because at any time a rider could be close . In case of the driver not assuring before exiting , it may hit the bycicle rider , resulting in an accident.

The propper implementation and securing the bycicle lane within the current environment can be more safe and easier to navigate.

2. TECHNICAL REQUIREMENTS

The bycicle or electric scooter rider can be travelling at speed limit of 25 km/h or lower in a open or conglomerate surroundings with slow or fast traffic . The rider will opt to use the bike lane if the infrastructure allows it , when the bycicle lane is not present , the rider will travel on road among other vehicles , by keeping close distance to the very right of the road available. It is forbidden for bycicles and electric scooters to travel on the side walk , excepting mobility scooters.

The dooring accident may occur due to the driver or passager is not assuring when it is opening the door : Eg (Taxi or ride-sharing passagers) due to lack of visibility , distraction or lack of awareness . These effects can happen to the rider as well , as such the lack of visibility or awareness can bring into difficult situations , in worst case , an accident.

The damage from this kind of accident may vary , from minor material damage such as a bent rim or forced doors , to a substantial amount of damage that can have material damage and personal injuries , In worst case the rider that is being doored , may be projected into the oncoming traffic or hitting a hard obstacle.

The safety equipment in some countries are mandatory or recomended to be used by riders , like helmets , joint protection , special clothing .

- The helmets
- Joint protection elements.
- Bike clothing

The occurance of a dooring accident is rather low compared to front end collisions , but it has multiple factors like infrastructure , clutterness and population education about preventive safety on the road.

The rise of the number of rider is influenced by the infrastructure , fuel prices , vehicle taxes and maintainance fees , clogged traffic at rush hours and the local govermental support to diversify the traffic .

2.1. OBJECTIVES

The main objectives of this study are the determination of the time of reaction for the bycicle rider at 25 km/h, simulation of a dooring accident , the determination of NIC (neck injury criteria) and HIC (head injury criteria) values for the rider that was doored.

2.2. METHODOLOGY

The methodology used for this experiment consists of 2 experiments: the time needed for the bicycle to avoid collision with a vehicle door; the simulation of the dooring accident.

- Target
- Tracking software
- High-definition camera
- Crash simulation software
- Microsoft Excel

The experiment consists in analyzing the door opening time at different intensities in order to obtain the speed of the door and the time needed to create an obstacle for the incoming cyclist.

The reaction time of the cyclist when faced with an obstacle can be varied by individual awareness, experience, speed, age, and the nature of the oncoming obstacle. The average reaction time of a person to respond to visual stimulus is approximately 0.8 seconds in order to react, like steering and braking, in order to avoid collision.

Fig. 2.1. The first experiment setup with tracking target installed

Experiment	Initial data					Accident prevention			
	Reaction time	Door opening time	Door length	Door speed		Bycicle speed		time	Distance
No.	tr [s]	td [s]	ld [m]	vd [m/s]	vd [km/h]	v [m/s]	[km/h]	tp [s]	dp [m]
1	0.8	2.35	0.89	0.379225	1.36521	6.94444	25	3.15	21.8534
2	0.8	2.32	0.89	0.384225	1.38321	6.94444	25	3.12	21.6413
3	0.8	2.47	0.89	0.360324	1.29717	6.94444	25	3.27	22.7083
4	0.8	2.80	0.89	0.31748	1.14293	6.94444	25	3.60	25.0231
5	0.8	1.22	0.89	0.730506	2.62982	6.94444	25	2.02	14.0162
6	0.8	2.80	0.89	0.31748	1.14293	6.94444	25	3.60	25.0231
AVG	0.8	2.32637225	0.89	0.38257	1.37725	6.94444	25	3.1264	21.7109
MAX	0.8	2.80333	0.89	0.31748	1.14293	6.94444	25	3.6033	25.0231
MIN	0.8	1.218333	0.89	0.730506	2.62982	6.94444	25	2.0183	14.0162

Table 2.1 Initial data processed to determine reaction time

For the simulation of the accident, we use top and side view to observe how the collision takes place.

Fig.2.2. Bicycle lane implementation in the city of Brasov, Romania

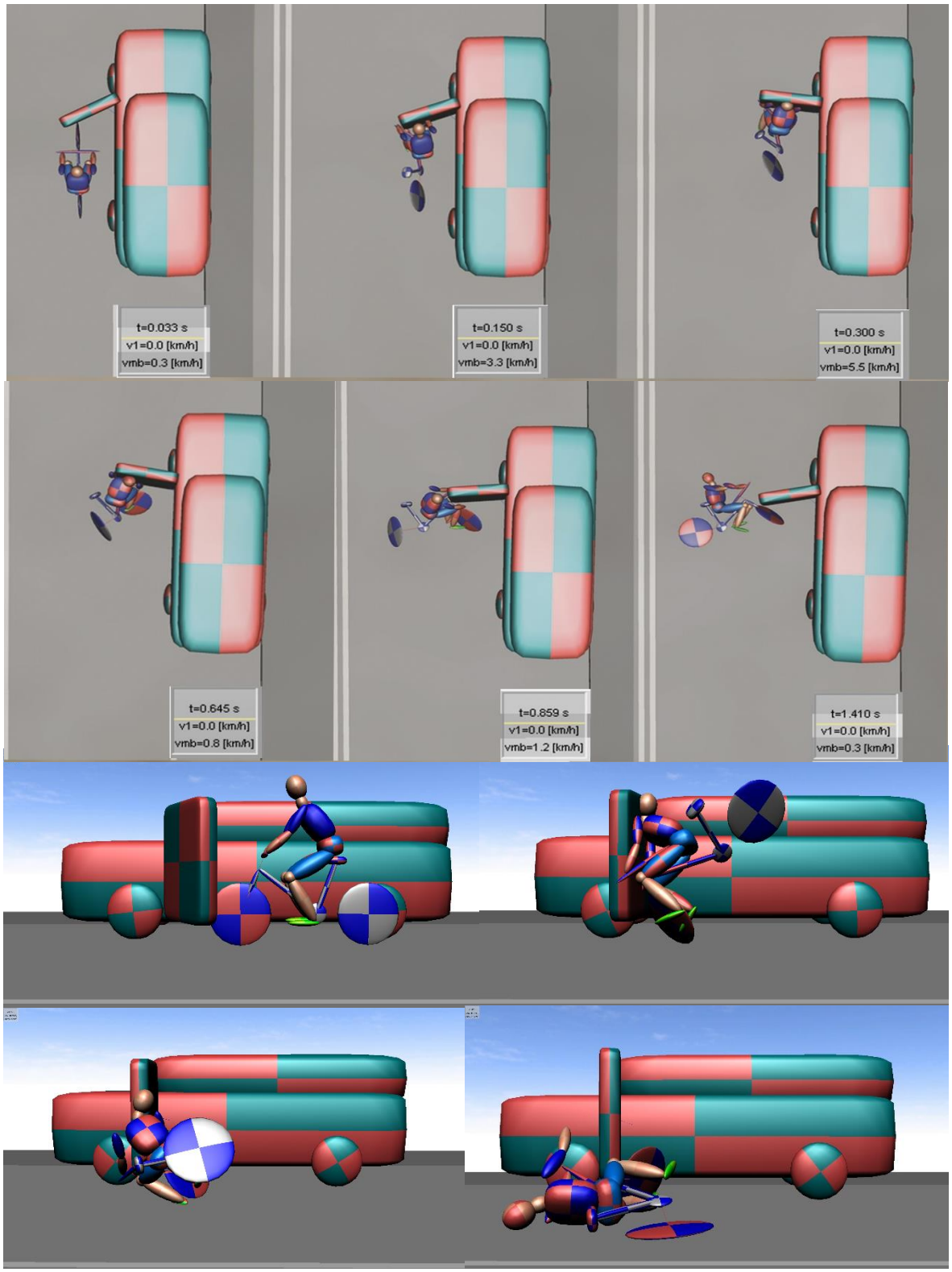


Fig.2.3. Dooring simulation top and side view representations

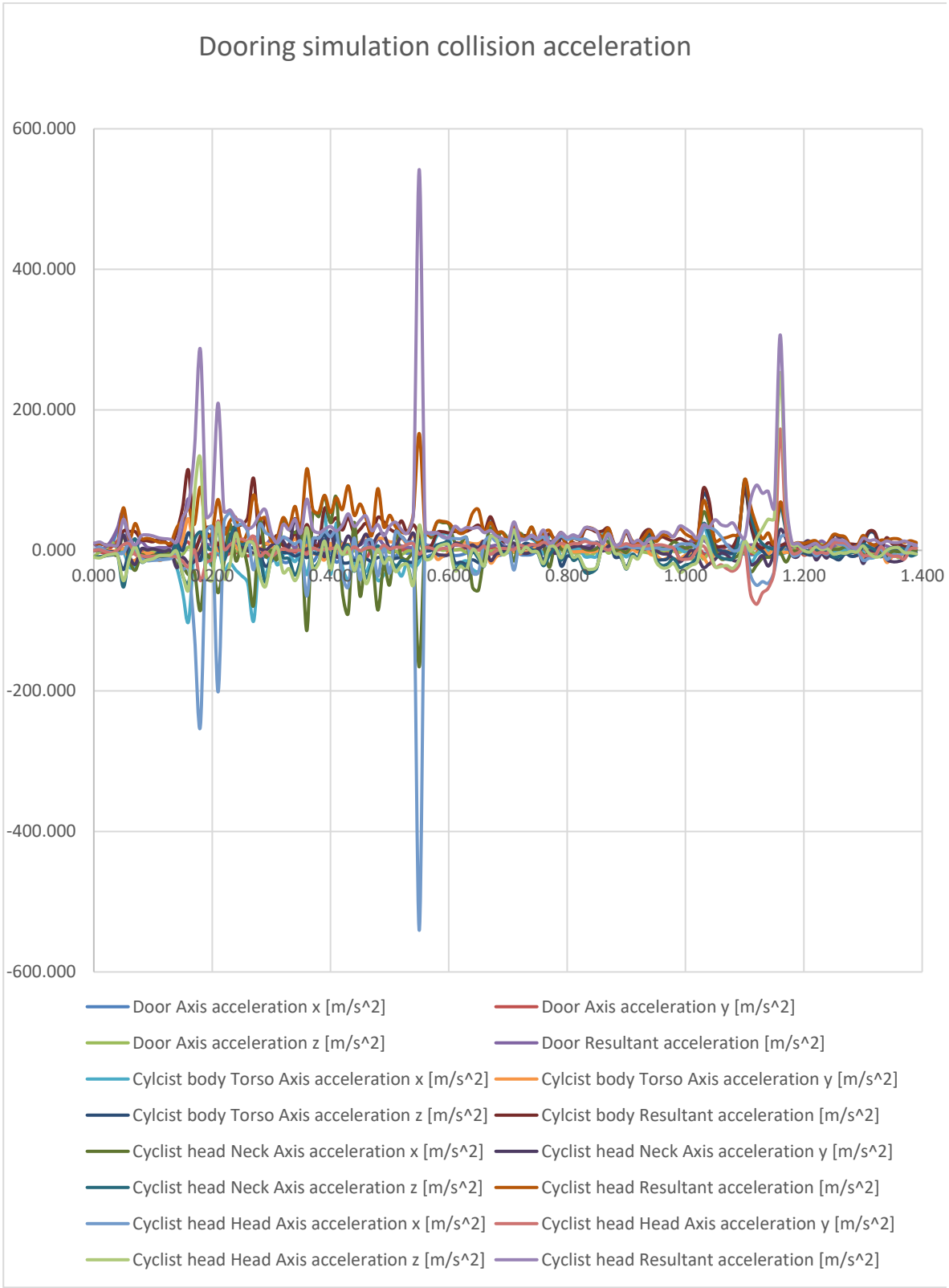
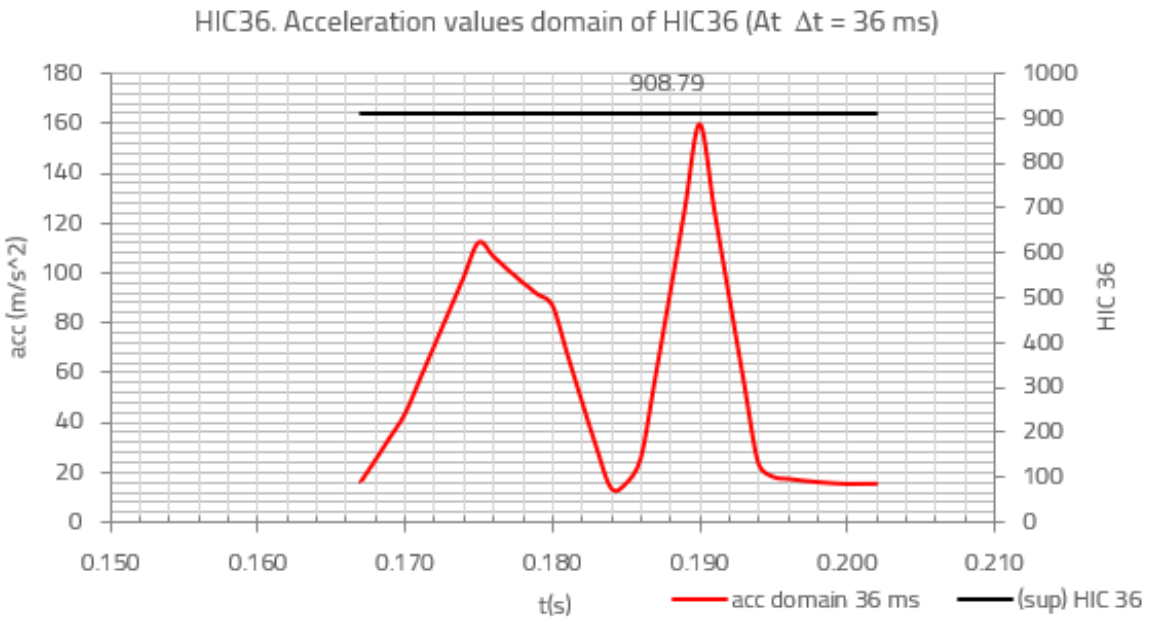


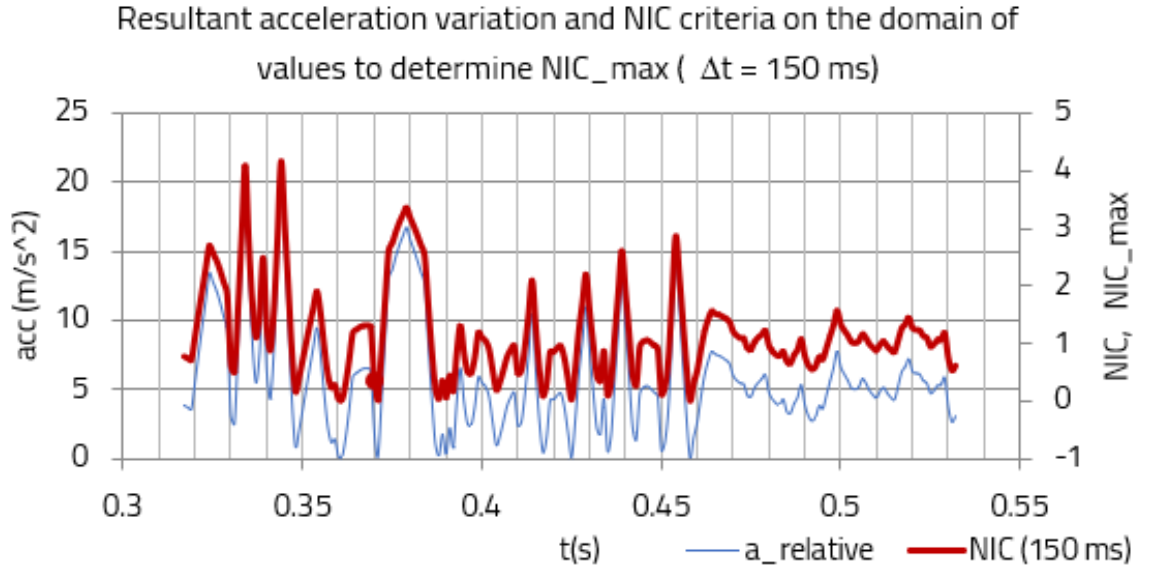
Fig.2.4.Resultant acceleration within the collision

Comparing the values:



	Value of HIC36:	908.787
	Limit value of HIC36 = 1000	Under limit.

Fig.2.5. Graph of Head injury criteria of the collision with limit values



	Parameter value of NIC:	19.8
	Limit value NIC = 15 m^2/s^2	Over limit !

Fig.2.6. Graph of Neck injury criteria of the collision with limit values

3. CONCLUSIONS

The dooring accident simulation vividly illustrates the real and potentially life-threatening nature of dooring accidents.Vulnerable road users, such as cyclists and motorcyclists, are particularly at risk in these accidents, necessitating attention and precaution.

The speed of the vehicle and driver distraction were evident as significant factors influencing the severity of dooring accidents in the simulation.

The act of opening vehicle doors safely, including the use of the Dutch Reach technique, emerged as a crucial practice to mitigate risks.

The simulation reveals a pressing need for public awareness campaigns to educate individuals on the dangers and consequences of dooring accidents.

Afterthoughts on Infrastructure Improvement and Education Awareness:

Infrastructure improvements should prioritize the establishment of protected bike lanes, separated from motor traffic, to mitigate the risk of dooring accidents.

Comprehensive education campaigns targeting both motorists and cyclists should underscore safe door opening practices and mutual respect between road users.

Driver education programs should incorporate modules on sharing the road with vulnerable users, emphasizing proper mirror use and the Dutch Reach technique.

The integration of technological solutions, such as sensors and warning systems in vehicles, can significantly reduce the occurrence of dooring accidents.

Stricter enforcement of traffic laws related to dooring accidents, accompanied by penalties for offenders, can serve as a deterrent and promote road safety.

Community involvement in road safety initiatives is essential, as local engagement can help in raising awareness and advocating for safer road infrastructure.

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