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Analysis of an accident by the lack of respect for priority

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ABSTRACT

This article focus on the resulting of mathematical simulation of system man-vehicle-surrounding in accident reconstrucion. We will examine an accident situation in its three stages when two vehicles and two pedestrians participate in a crash. The first vehicle moving along the national highway A_1 in the direction of the location *A* to location *B*; A_2 second vehicle moving along the national road in the direction from locality to locality *D-C* and two pedestrians were crossing the white lines. As a result of the collision of the two vehicles, the collided vehicle hits the two pedestrians as well. Severely damaged in the accident, the driver and passenger of A_1, also severely damaged remained the two pedestrians who were crossing the white lines. From the study we will do, the calculation of the speed of movement of vehicles involved in the accident using one of the ways to solve this problem, will be sufficient.

Keywords

Accident investigation, simulation models, plan of collision.

Academic Discipline And Sub-Disciplines

Statistics;

1. INTRODUCTION

In the practice of analyzing accident situations, two basic groups of procedural methods are of practical application, which use mathematical models of system man–vehicle–surroundings and data loggers. In the case of mathematical models, uncertainty in an analysis result mainly from: accuracy of defining the models' parameters and adopted model structure. In the case of the devices recording the motion parameters, adulteration of results may result from measuring errors of the values characterizing the vehicle's motion and the errors resulting from processing of the recorded volumes. We concentrate on the first procedural method: an analysis by means of mathematical models of system man-vehicle-surroundings which are applied on simulation models. Then with the help of Virtual CRASH software we have built dynamics of the occurrence of traffic accidents.

2. MATHEMATICAL SIMULATION

In cases such as the present, the first work to be done is that of the device with a plan as accurate as possible and then draw the locations of the first contact that should be compatible with the tracks left on the road by two means as well as their deformed condition. By these properties it is then possible to evaluate the spins and linear movements under which the two automobiles have gone under in the movement from the first contact location on to the final location.

Spins and displacement (centre of importance) provided as follows:

α_1 = 137˚= 2,4 rad - rotation A_2 (running clockwise)

α_2 = 107˚= 1,9 rad - rotation A_2 (running anti-clockwise)

S_1 =7.90 m - linear displacement of the center of importance of A_2

S_2 =7.40 m - linear displacement of the center of importance of A_1

To calculate the velocity, we apply the principle of sustainability of the amount of movement principle that physically adjusts the phenomenon of collision mechanics. Note:

m_1 - measures of A_2 with two people on board

m_2 - measures of A_1 with two people on board

v_1 - the velocity of A_2 before the collision

v_2 - the velocity of A_1 before the collision

v_1' - the velocity of A_2 after the collision

v_2' - the velocity of A_1 after the collision

θ_1 - the angle formed by the vector v_1 with a reference line l.d.r.

θ_2 - the angle formed by the vector v_2 with a reference line l.d.r.

θ_1' - the angle formed by the vector v_1' with a reference line l.d.r.

θ_2' = the angle formed by the vector v_2' with a reference line l.d.r.

Now writing on the principle of sustainability vector form of the quantity of movement

$$m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{v}_1' + m_2\vec{v}_2'$$

$$\vec{v}_1 + \frac{m_2}{m_1}\vec{v}_2 = \vec{v}_1' + \frac{m_2}{m_1}\vec{v}_2'$$

$$v_1\cos\theta_1 + \frac{m_2}{m_1}v_2\cos\theta_2 = v_1'\cos\theta_1' + \frac{m_2}{m_1}v_2'\cos\theta_2' \quad (1)$$

then

$$m_1 = \frac{2.080+1.40}{9.81} = \frac{2.220}{9.81} = 226 \text{ kg m}^{-1} \text{ s}^2$$

$$m_2 = \frac{890+140}{9.81} = \frac{1.030}{9.81} = 105 \text{ kg m}^{-1} \text{ s}^2$$

$$\frac{m_2}{m_1} = \frac{105}{226} = 0.46$$

θ_1 = 0 andcos 0 = + 1,00

θ_2 = 111° and cos 111° = - cos(180° -111°) =- cos 69° = - 0,36

θ_1' = 4° and cos 4° = + 0,99

θ_2' = 16° and cos 16° = + 0,96

Now, equation (1) is the same with:

$$v_1 + 0.46v_2(-0.36) = v_1' + 0.46v_2'(+0{,}96)$$

$$v_1 - 0.17v_2 = v_1' + 0.46v_2' \quad (2)$$

We see that after the collision velocities – listed with v_1' and v_2' - can be determined primarily on the theoretical route by considering only linear displacements S_1 and S_2 by the formulas:

For the second vehicle A_2

$$v_{1_0}' = \sqrt{2g\, f\, S_1} = \sqrt{2 \text{ x } 9.81 \text{ x } 0.40 \text{ x } 7.90} = \sqrt{62} = 7.9\text{m/s} = 7.9 \text{ x } 3.6 = 28 \text{ km/h}$$

For the first vehicle A_1

$$v'_{2_0} = \sqrt{2\ g\ f\ S_2} = \sqrt{2\ x\ 9.81\ x\ 0.40\ x\ 7.40} = \sqrt{58} = 7.6 m/s = 7.6\ x\ 3.6 = 27\ km/h\ .$$

Also, for the first and second vehicle (A_2 and A_1) we calculate:

$$v'_{*1} = \sqrt{g\ f\ p\ \alpha_1} = \sqrt{9.81\ x\ 0.45\ x\ 2.54\ x\ 2.4} = \sqrt{27} = 5.2 m/s = 5.2\ x\ 3.6 = 19\ km/h$$

$$v'_{*2} = \sqrt{g\ f\ p \alpha_2} = \sqrt{9.81\ x\ 0.45\ x\ 2.39\ x\ 1.9} = \sqrt{20} = 4.5 m/s = 4.5\ x\ 3.6 = 16\ km/h$$

Now we obtain the velocity after collision:

For vehicle A_2

$$v'_1 = v'_{1_0} + v'_{*1} = 28 + 19 = 47\ km/h = 47/3.6 = 13.1\ m/s$$

For vehicle A_1

$$v'_2 = v'_{2_0} + v'_{*2} = 27 + 16 = 43\ km/h = 43/3.6 = 11.9\ m/s$$

But in fact due to the collision with the small wall of the A_1 (to the point that a thicker part collapsed) obtained value of 11.9 m/s must be increased to at least 40% so the velocity will handle the final value of v'_2 = 1.40 x 11.9 = 16.7 m/s. After the end velocities v'_1 dhe v'_2 are determined and their values in formula (2) can be substituted

$$v_1 - 0.17\ v_2 = v'_1 + 0.46\ v'_2$$

$$v_1 - 0.17 v_2 = 13.1 + 0.46 x 16.7$$

$$v_1 - 0.17 v_2 = 20.8 \quad (3)$$

Since (3) contains two unknowns and should be placed beside a second equation which is one that is obtained by examining the collision coefficient *K* determined by:

$$K = \frac{v'_2 - v'_1}{v_1 - v_2}$$

$$K = \frac{v'_2\ \cos\ \theta'_2\ -\ v'_1\ \cos\ \theta'_1}{v_1 \cos\ \theta_1\ -\ v_2\ \cos\ \theta_2}$$

For this case we have:

$$K = \frac{v'_2\ (+0,96)\ -\ v'_1\ (+1,00)}{v_1\ (+1,00)\ -\ v_2\ (-0,36)} = \frac{0.96\ v'_2\ -\ v'_1}{v_1 +\ 0.36 v_2}$$

or

$$v_1\ +\ 0.36\ v_2\ =\ \frac{0.96\ v'_2\ -\ v'_1}{K}$$

after substituting the formula of v'_1 dhe v'_2 we have

$$v_1\ +\ 0,36\ v_2\ =\ \frac{2.9}{K} \quad (4)$$

Combining (3) and (4) we have the solver system of calculating problem of the speed of the initial contact v_1 and v_2 of two vehicles

$$\begin{cases} v_1 - 0.17\, v_2 = 20.8 \\ v_1 + 0.36\, v_2 = \dfrac{2.9}{K} \end{cases}$$

By the solution of which we obtain $v_2 = -\dfrac{20.8\,K - 2.9}{0.53K}$

Giving *K* a value acceptable to the characteristics of the inelastic collision tends due to large deformations consistent findings on two vehicles, ($K \in (0.20, 0.30)$) and have averaged *K*=0.25, then

$$v_2 = |17.4| \text{ m/s} = 17.4 \text{ x } 3.6 = 63 \text{ km/h}$$

And the absolute value v_2 = 17,4 m/s.

By substituting the value found of v_2 in the formula (3) we have:

$$v_1 = 17.8 \text{ m/s} = 17.8 \text{ x } 3.6 = 64 \text{ km/h}$$

So basically the calculation brings subsequent valuations of the speeds of two vehicles at the time of the crash:

v_1 = 64 km/h = 17.8 m/s - velocity of A_2

v_2 = 63 km/h = 17.4 m/s - velocity of A_1

V_i movement velocity is achieved by examining the braking distance before contact was:

- vehicle A_2: S_1= 10.80 metra

$$V_1 = \sqrt{v_1^2 + 2\text{ g f } S_1} = \sqrt{17.8^2 + 2 \text{ x } 9.81 \text{ x } 0.80 \text{ x } 10.80} = \sqrt{317 + 170} = \sqrt{487} = 22.1 \text{ m/s} = 22.1 \text{ x } 3.6 = 80 \text{ km/h}$$

- vehicle A_1: $S_2 = \dfrac{3.50 + 6.00}{2} = \dfrac{9.50}{2} = 4.75$ m

$$V_2 = \sqrt{v_2^2 + 2\text{ g f } S_2} = \sqrt{17.4^2 + 2 \text{ x } 9.81 \text{ x } 0.90 \text{ x } 4.75} = \sqrt{303 + 72} = \sqrt{375} = 19.4 \text{ m/s} = 19.4 \text{ x } 3.6 = 70 \text{ km/h}$$

3. COMPUTER MODELING OF ROAD ACCIDENT

With the help of Virtual CRASH software we have built dynamics of the occurrence of traffic accidents presented in the following figures. This picture gives the possible points of attack and the plan of collision of the two vehicles taken under study, as well as the insertion of the two vehicles into each other.

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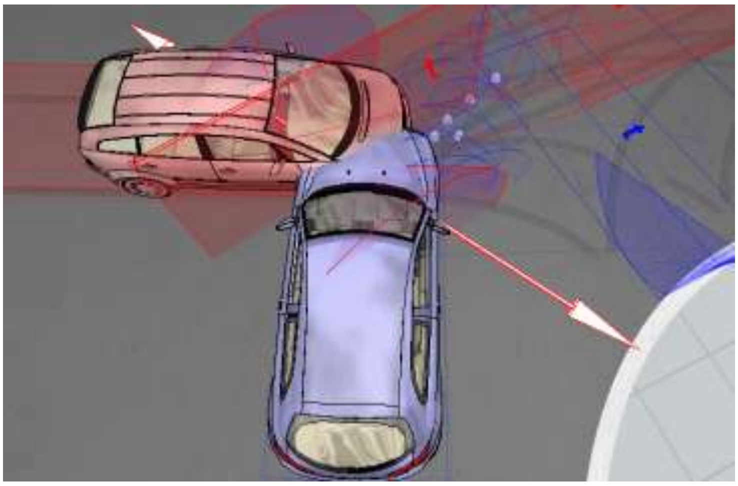

Fig 1: The first phase of the development of the contact and deformation.

The figure below presents the development of contact between the two vehicles to the maximum deformation and then begins to separate them, then the second phase of the collision.

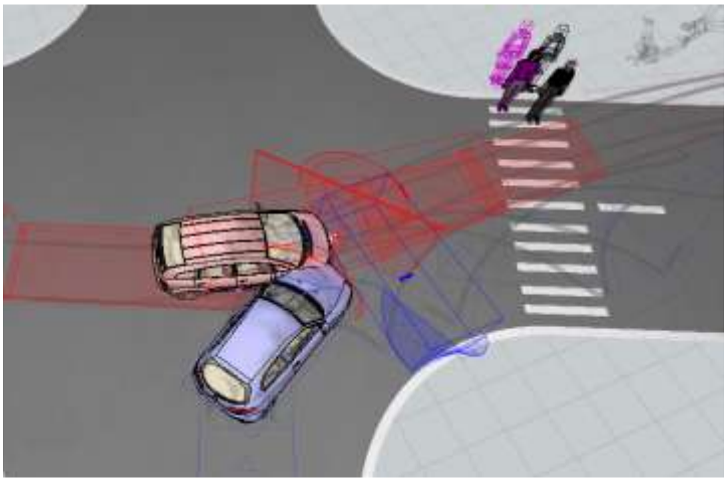

Fig 2: The second phase of the collision.

Fig.3 is the third phase of the breaking point of the two vehicles. Because of the spinning moments the vehicles collide together again, and also given the position of pedestrians who comply with the trajectory of the vehicle in pink which entreated the intersection with a red light and then hit the pedestrians.

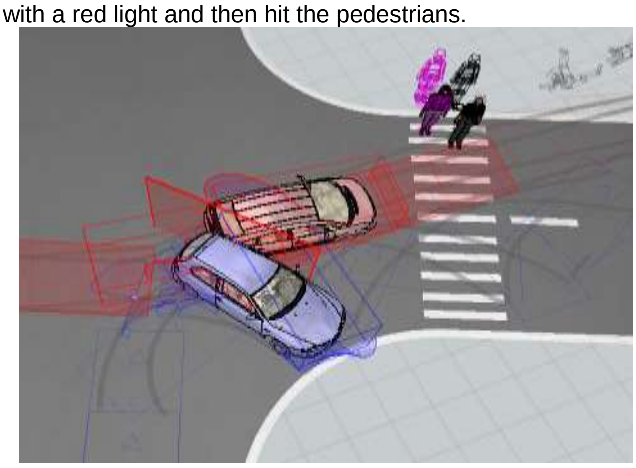

Fig 3: The third phase of the breaking point of the two vehicles.

4. CONCLUZION

The values found for the speed of movement of two vehicles show:

a) for the vehicle A_2, a speeding regarding border (taken equal to that existing in A_1 namely driving 50km/h) which is known in the waiting area of widely hazard warning and situation of countries (Article 41 and 139 of the Highway Code).

Overcoming = $\frac{80-50}{50} = \frac{30}{50} = +60\%$

b) for the vehicle A_1, failing to stop at the stop located at the exit from the road crossing the (violation of Article 40 of the Highway Code), because if it was given the rest to reach the crash at a speed of 70km/h = 19.4 m/s in the confined space of S = 6,50 meters should have won an acceleration:

$$a = \frac{v^2}{2S} = \frac{19.4^2}{2 \times 6.5} = \frac{376}{13} = 29\, m/s^2$$

In a time of $t = v/a$ = 19.4/29 = 0.7s violation of Article 40, 139 and 143 of the Highway Code. While not stop at Stop and instead taking a crossing speed of 19.4 m/s to reach Stop the clash of traversing 6.5 meters has occupied a time $t = s/v$ = 6.5/19.4 = 0.3 s, value that gives an idea of the acceleration of velocity of the occurrence.

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