THE RETROFITTING OF TRUCKS ALREADY BEING IN USE IN POLAND IN A RANGE OF THE INDIRECT VISIBILITY

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Abstract

The paper discusses the need of additional equipment of trucks which are already being in use in Poland with the devices of the indirect visibility which enable to observe much bigger area in the neighbourhood of the vehicle. A large number of accidents are caused by drivers of larger vehicles who are not aware that other road users are very close to or beside their own vehicle. These accidents are often related to a change of direction at crossings, junctions or roundabouts, when drivers fail to detect other road users in the blind spots, which exist in the immediate area around their vehicles. The increase of the indirect visibility from the driver's seat improves safety of the participants in the road traffic. Over 400 people lost their life in the EU in of these accidents. Most of the victims of such accidents are pedestrians or two-wheelers, a particularly vulnerable category of road users. Implementation of the EU Directive 2003/97 (which is obligatory for the new vehicles) to the vehicles earlier registered can be done by replacement and installment of the new mirrors which contain bigger areas. This paper shows the results of the research on the independence of minimum dimensions (s, w) of mirrors class V and its placement on values of radius of curvature. It contains much bigger area than it is due to demands. Author also made a proposition on how to solve the problem of the limited visibility on the inclined crossing of roads and on enlarged crossing while turning left.

***Keywords**: safety, transport, visibility*

1. Introduction and definition of the problem

The following sentences are the European Commission's opinion on the problem of the road safety and particularly on the issue of visibility. „A large number of accidents are caused by drivers of larger vehicles who are not aware that other road users are very close to or beside their own vehicle. These accidents are often related to a change of direction at crossings, junctions or roundabouts, when drivers fail to detect other road users in the blind spots, which exist in the immediate area around their vehicles. It is estimated that every year, over 400 people lose their life in the European Union because of these accidents. Most of the victims of such accidents are pedestrians or two-wheelers, a particularly vulnerable category of road users. The European legislator has been attentive to this problem. In 2003, the European Parliament and the Council adopted Directive 2003/97/EC on the approximation of the laws of the Member States relating to the type-approval of devices for indirect vision and of vehicles equipped with these devices. According to this directive, in 2006 new vehicle types and respectively in 2007 new vehicles can only be granted approval by the Member States' authorities if they are equipped with a set of mirrors and other systems of indirect vision fulfilling certain requirements in order to reduce their blind spots. While this legislation is clearly beneficial, existing trucks are not covered by it. Given the life-time of heavy goods vehicles (HGV), the effect of the new legislation is therefore quite limited for a long period of time. This means that the HGV fleet will be completely exchanged in about 16 years, i.e. in 2022 at the earliest. Given this slow replacement rate, the blind spot problem remains relevant for a long period of time, until the vast majority of vehicles still equipped with less performing systems for indirect vision will be withdrawn from circulation after 2020. If nothing is done, the high risk to vulnerable road users of being involved in accidents with HGV due to their lateral blind spots, above all on the passenger's side, is thus bound to continue for many years."

2. Research on HGV retrofitting possibilities

Amongst others I was carrying on research on the dependence between minimal width and minimal height from the radius of mirror's curvature (mirror class V - close proximity). Also there exists the dependence of height of fitting the mirror over the ground.

Two example graphs of research work for b = 2400 mm are shown below (see Fig. 2, 3). These graphs consist of information about minimal width and height of mirrors in function of the radius of mirror's curvature which fulfils the requirements of EU Directive 2003/97 (see Fig. 4).

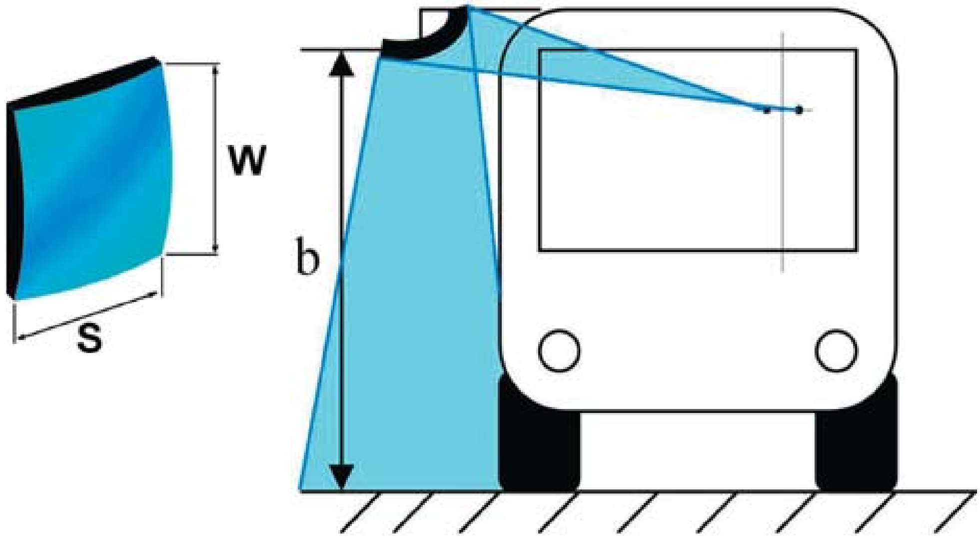

Fig. 1. Scheme of measuring mirror's height - b, class V (close proximity) over the ground and dimensions of mirror

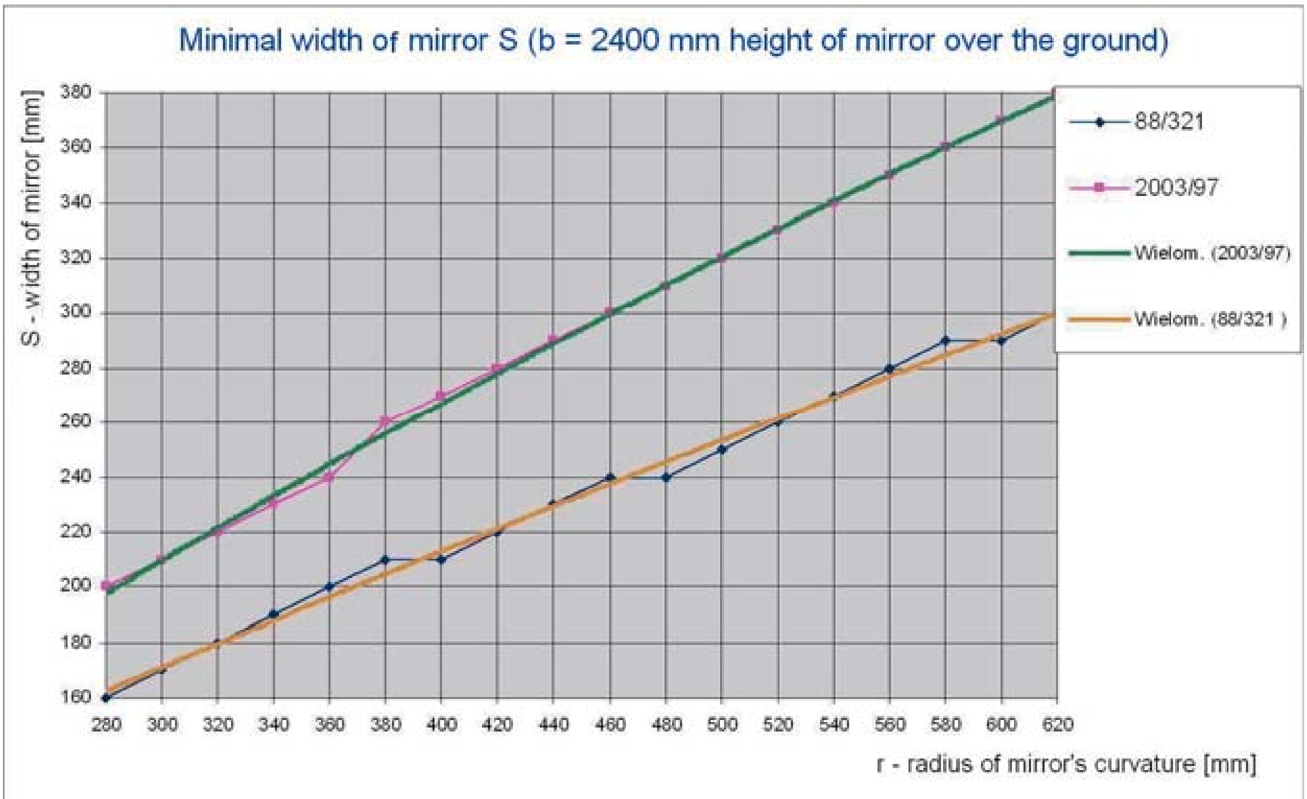

Fig. 2. Research example - minimal width of mirror S (b = 2400 mm height of mirror over the ground) in function of r - radius of mirror's curvature

Fig. 3. Research example - minimal height of mirror W (b = 2400 mm height of mirror over the ground) in function of r - radius of mirror's curvature

From my research work it appears that while designing HGV constructors were choosing the mirrors in that way that the minimal required level was usually picked up. According to the requirements of the new EU Directive 2003/97 the radius of mirror's curvature is decreased till r = 300 mm, under these conditions it is not possible to keep the same dimension of mirror's housing and at the same provide the right visibility. It is necessary to use bigger mirrors particularly when the height of placing the mirror over the ground is close to 2 m for mirrors class V (close proximity).

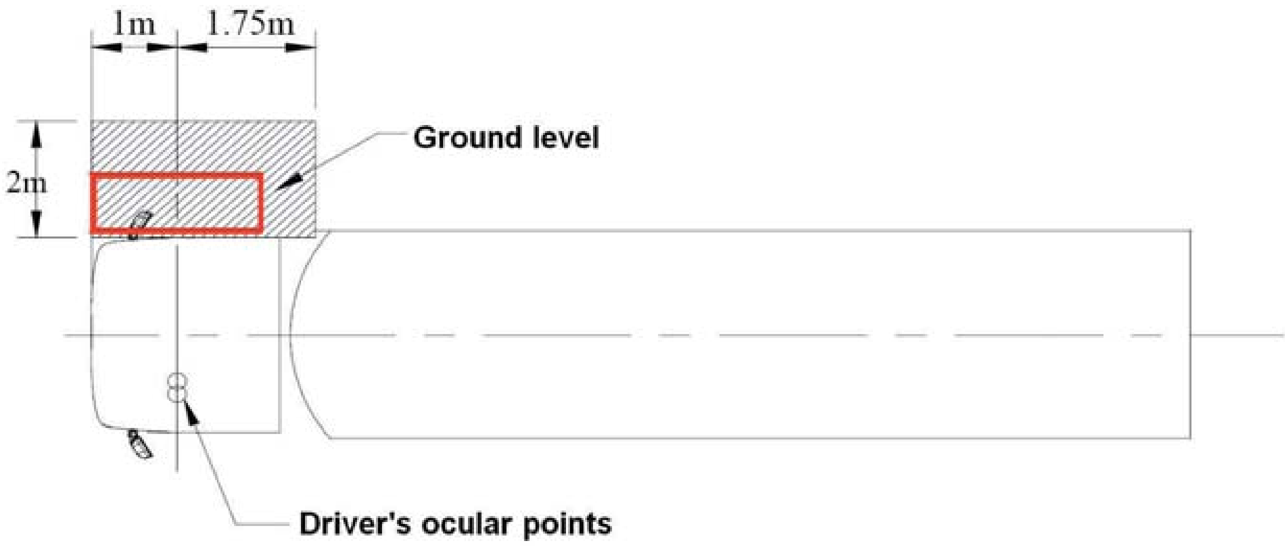

Fig. 4. Placement and vastness of the visibility field for the mirror of close vision class V for the certain vehicle categories and cases mentioned in the Directive – hitherto demand is marked by thickened line

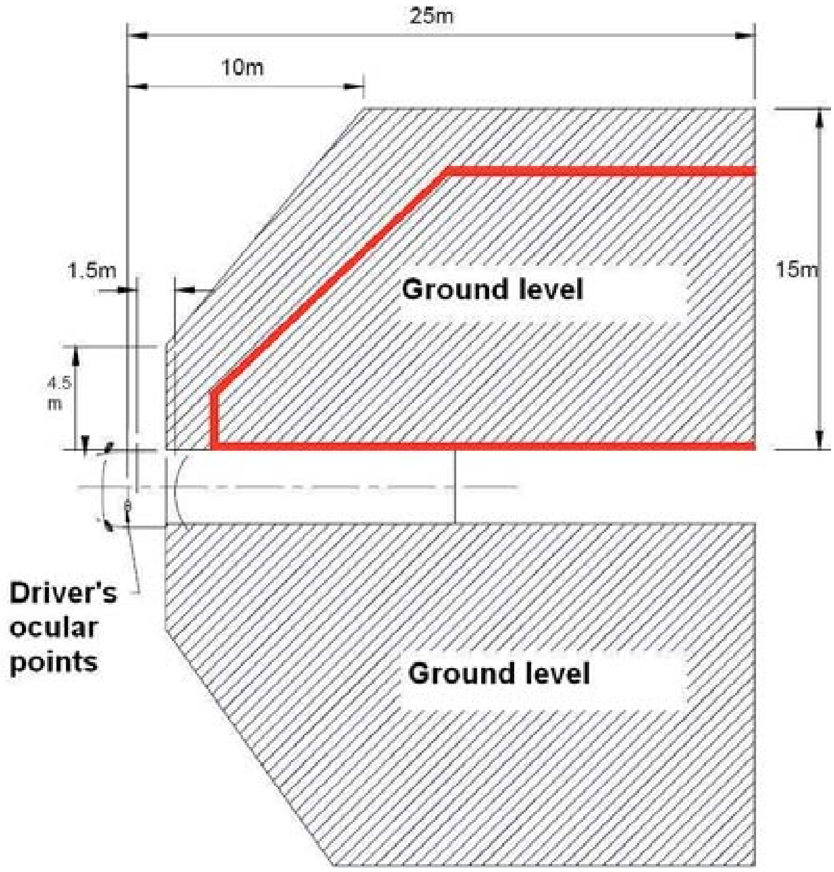

Fig. 5. Placement and vastness of visibility fields for wide-angle mirrors class IV for certain vehicle categories and cases mentioned in the Directive - hitherto demand is marked by thickened line

Braking visibility distance $\boldsymbol{L_{WH}}$ (so called vehicle dynamic distance [m]) is calculated from the following formula:

$$L_{WH} = 0{,}278 t_r v_m + \frac{v_p^2}{254(\psi_{xR}\eta \pm i_n)}, \tag{1}$$

where:

v_m - reliable velocity [km/h],
$\boldsymbol{t_r}$ - driver reaction time [s],
$\boldsymbol{V_0}$ - car velocity at the beginning of breaking [m/s],
η - longitudinal traction adhesion utilisation coefficient,
ψ_{xR} - longitudinal traction adhesion coefficient,
i_n - road sloping up or sloping down („+" up hill drive, „–" down hill drive).

Breaking distance and braking visibility distance is being determined by taking into account, the fact that during breaking the vehicle kinetic energy is being decreased. The essential factor of the braking process is tyre's adhesion to the surface. Braking distance is being established by comparing vehicle braking work and kinetic energy. Apart from that, the road distance covered with the initial velocity during the driver reaction time ($\boldsymbol{t_r}$) gets added to the equation. In Poland reliably velocity v_m is used. Minimal reaction time is estimated at (0.96 - 1.27) s.

Mirrors class IV (wide angle) after the modification are giving too small observation area. It is enough for the HGV driver to observe the pedestrians, motor bikers, motorcicklers during his turn into the right (see Fig. 10). On angular intersections the HGV driver is not still able to observe other vehicles in far distance which are coming from the right side (see Fig. 10). This problem should be in future resolved for new and used HGV.

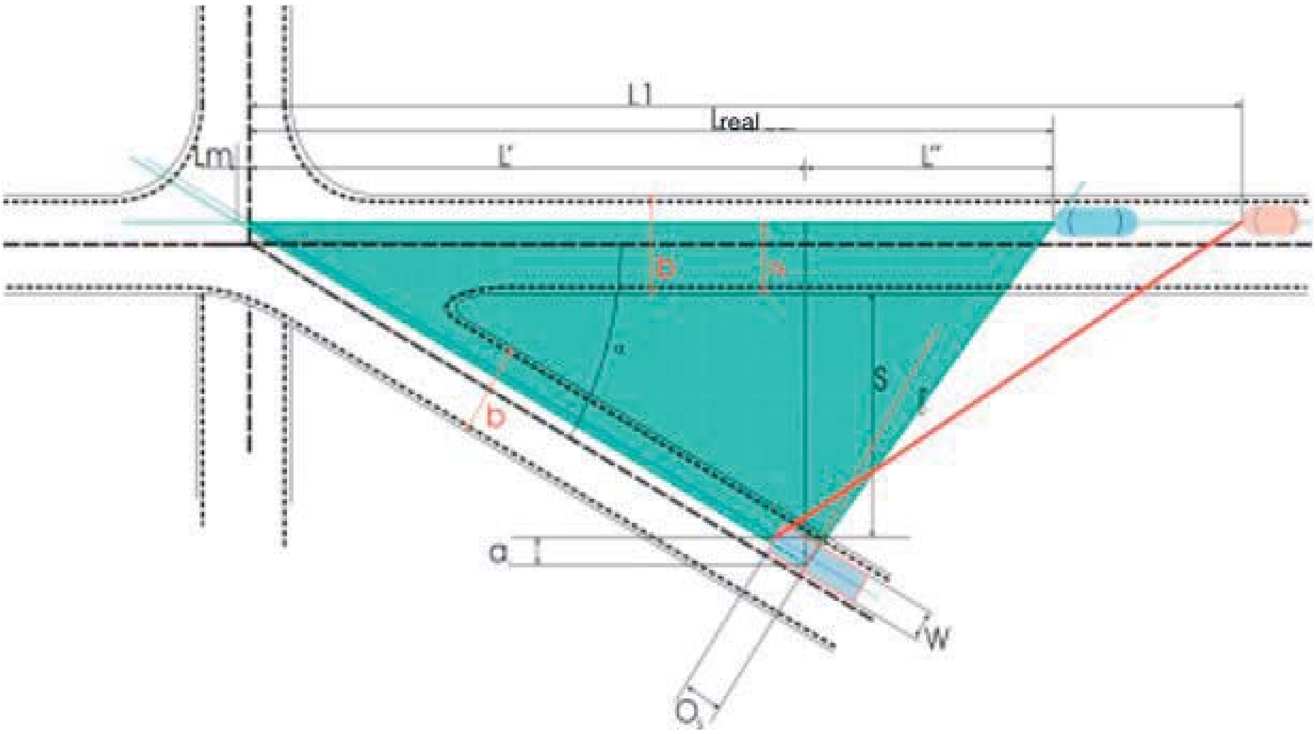

Fig. 7. Area of the real visibility (α = 30°, γ = 7°)

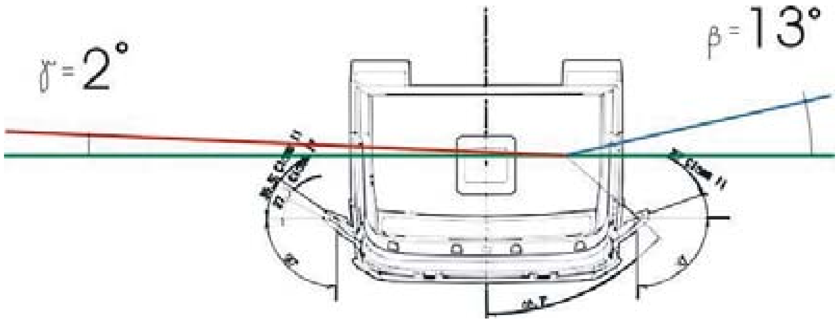

Fig. 8. Characteristic angles of vehicle cabin visibility field

$$L_{real} = \left[S + a_1 + \frac{3}{4} b \right] \left[ctg\alpha + tg(\alpha + \gamma) \right] - \frac{b}{8 \cdot tg\alpha} . \tag{2}$$

Formula (2) describes dependence of real visibility values - $L_{real} = f(s, \alpha, \gamma)$. The results of calculation are illustrated on graphs (see Fig. 9).

Values, which dimensions knowledge is necessary to point out the range of visibility field are following:

$a = a_1 + a_2$, where: $a_1 = \left(o_s + \frac{W}{4 tg\,\alpha} \right) \sin\,\alpha$ - distance between eye-points and a tangent crossing by extreme centre point on the front bumper, $a_2 = \frac{3}{4} b$,

where:

b - width of the road,

Vm - flow traffic speed - mean parameter mapping the speed of vehicles on free road traffic, used o determine road elements dimensions value, which on traffic safety consideration should be adjusted to this speed,

L_1 - distance measured according to Fig. 7, demanded by the traffic regulations while reaching an intersection with a measured speed road,

L_2 - distance measured according to Fig. 7, demanded by the traffic regulation while start moving to an entry at the intersection with a measured speed road,

L_{real} = L'+L" - L_m - real length of visible area from a vehicle, measured like an L_1,

L'; L"; L_m; - values on an intersection screen according to Fig. 7,

S - distance between vehicle on a side road and edge of main road,

b - main road width,

α - road's crosscut angle,

W - car width,

Os - distance between eye-points and perpendicular plane, crossing by a front outline of a vehicle,

α Є <25° - 90°> - such range taken, because in situation with obtuse angles, driver does not have any limits from the right and from the left - he can put out his head through a left window (it is unadvisable - driver switch his sight from a driving course),

S Є <0 m – 20 m> - maximal distance from the road edge, specified in the traffic regulations,

γ Є <0° - 10°> - such range taken according to testing of trucks category N_1, N_2, N_3.

The idea of increasing the observation area in wide angle mirrors (class IV) is not resolving the invisibility of vehicles coming from the right side (from the far distance) in the angular intersection (see Fig. 10, 11) and during turning into the left side on the big perpendicular intersection (see Fig. 10, 11). The lack of visibility in these mentioned situations leads to possible accidents on roads in Poland.

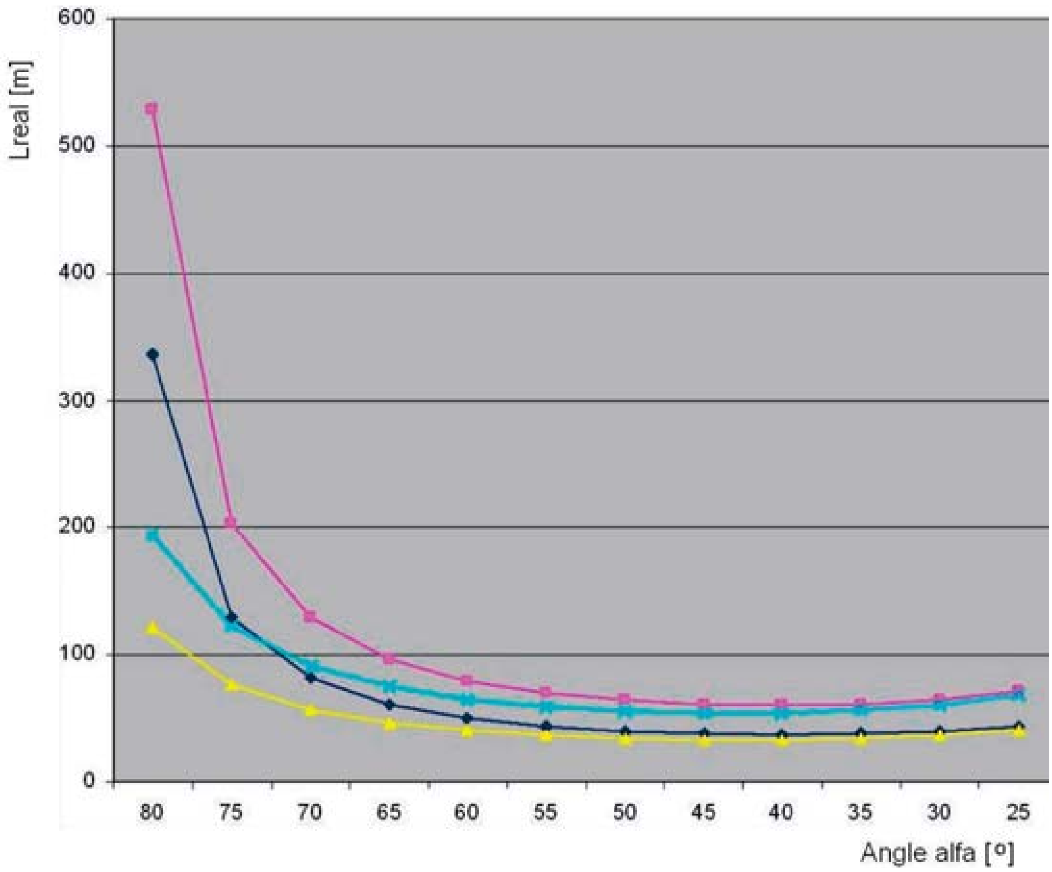

Fig. 9. Real visibility Lreal [m] in function of road crosscut angle alfa - truck approaching, the angular intersection L1 = 120 m, Vm = 60 km/h (two type of vehicle's and two distances)

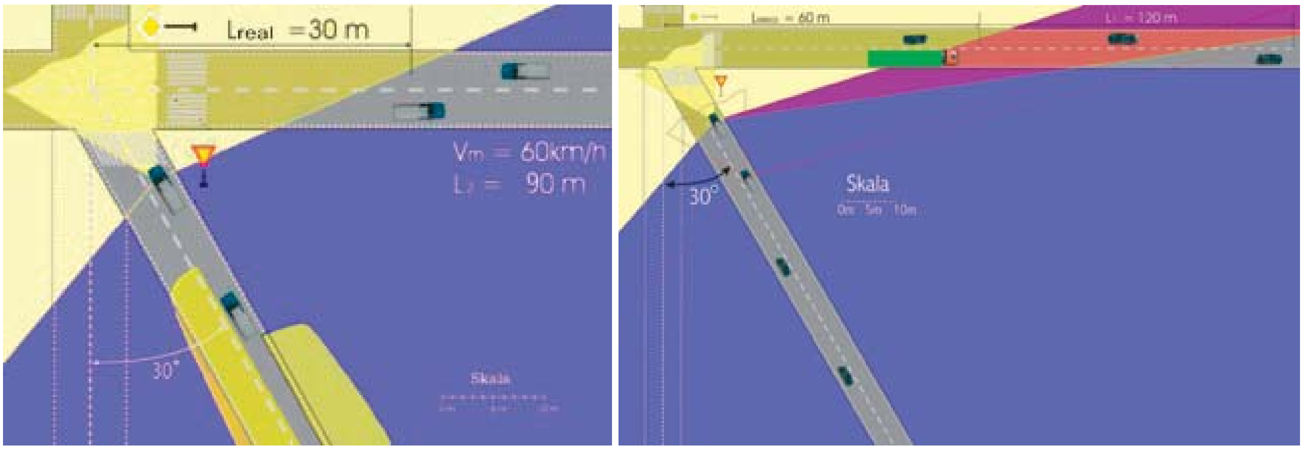

Fig. 10. Two situations: stopping at the angular intersection, and the truck in motion while approaching the angular intersection

Fig. 11. View of the big angular and perpendicular intersection

One of the methods of dealing with this problem is placing an additional, accurate mirror - class IV (wide angle) fitted in the cab of the HGV (see Fig. 12). This should allow observing invisible area from right side for a distance not smaller than 150 m.

Fig. 12. Extra spherical mirror in vehicle cab and view of mirror placement on the road with the lack of visibility

A different way of dealing with this problem is installing a big, wide angle mirror, placed on the angular intersection where the lack of visibility appears (see Fig. 12). It should allow the driver to observe invisible area from right side of the truck, which has not any additional mirrors fitted.

3. Conclusion

Some important facts: in Poland there are few HGV assembly plants; producers and decision makers of these HGV are not placed in Poland; the point of view of the HGV producer representatives is correlated with conclusions presented in this paper. In Poland, about 40 % of total amount of HGV used nowadays was produced before 1st of January 2000. That means that these HGVs are going to be excluded from retrofitting in mirrors: class IV (wide angle), class V (close proximity), which are in accordance, in discussed areas, with new EU Directive 2003/97. In Poland there is an important need of retrofitting these types of HGVs (produced before 1st of January 2000) - polish government should take it under consideration. Also polish mirrors producers should have an opportunity to incorporate the procedure of the EU Directive 2003/97 into their production processes. Particularly it is important because of a special characteristic of older HGVs used in Poland - different than in other EU Member States.

In Poland the responsible for the decision making in the field of transport did not prepare and assure the supply by polish producers of accurate mirrors which allow realizing the recommendations of the EU Directive 2007/38 in the case of retrofitting for indirect vision devices. Furthermore the adequate regulations ordering and describing rules in case of retrofitting vehicles in devices for indirect vision accordingly to the EU Directive 2007/38 were not published. There were no necessary research and analyses made on relationship between the existences of the dead angel with the number of accidents, though recommendation given in the Directive. Therefore it is not known if applying all the recommendation given in the Directive will bring decrease in the number of accidents.

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