EVSC05-13

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Advantages and benefits of using ESP in hazardous goods transporters

Introduction

Truck accidents leading to miles of tailbacks have a great effect on the public and damage the image of trucks. In particular, the risk potential from accidents involving hazardous goods transporters is clearly higher than that from accidents involving "normal" goods vehicles. This is reflected in public through spectacular reports of accidents in the press and continually fans the debate about the safety of these vehicles. The industry makes continuous efforts to contribute to reducing the risk by means of technical innovations.

Fitting hazardous goods transporters with active safety systems has up to now been limited to ABS, the statutorily prescribed anti-blocking system. In the recent past, ESP, the electronic stability programme, has prevailed in the private car sector as standard equipment even in the compact class. With ESP for commercial vehicles there is now an active safety system available whose great effectiveness in preventing articulated vehicles from jack-knifing and turning over [1] makes it desirable to use the system on a broad base, in particular for articulated vehicles.

This paper examines an accident with a hazardous goods transporter that took place in June 2001. This accident is simulated with the help of a Hardware-In-the-Loop (HIL) simulation and the effectiveness of ESP is proved. In addition, using a typical hazardous goods transporter accident as an example, an attempt will now be made to show the overall economic damage that is caused.

In conclusion, using statistical accident data and a study on the accident prevention potential of ESP the total economic damage will be assessed that could be avoided by a wide-ranging use of the system in hazardous goods transporters.

Study of an accident involving a hazardous goods transporter

The accident examined below was simulated initially without ESP with the data from an existing expert's report in a Hardware-in-the-Loop simulation. Following this, after adding ESP to the simulation an examination was carried out to establish how far ESP could affect the accident sequence.

Accident sequence

An articulated tanker carrying 20,000 l petrol and 14,000 l diesel was being driven on a main road near Offenbach (near Frankfurt, Germany) at a speed of approx. 50-60 km/h. Immediately in front of a bridge carrying the A3 autobahn over the road, on a left-hand bend that gradually became tighter, the truck tipped over as a result of the speed, which was too high for the bend. The tank was damaged and several thousand litres of fuel escaped (see Fig. 1). There was a danger of explosion because of the high summer temperature and both the main road and the autobahn running above it had to be cordoned off for several hours. This led to considerable traffic difficulties and tailbacks in the whole Offenbach area.

Fig. 1: Accident with articulated fuel tanker (Photo: Geo

Simulation results with/without ESP

In the simulation without ESP it was seen that, because of the speed at the start of the bend, the vehicle combination starts to incline clearly to the outside and then loses ground contact with the wheels on the inside of the bend as it continues. At this point at the latest the driver has no chance of avoiding turning over by applying the brakes. Opening the steering was not possible because of the space available.

In the HIL simulation with ESP the excessive vehicle speed is reduced on steering into the bend by reducing the engine torque with subsequent deliberate braking through ESP. The consequence is that the truck remains stable and tipping over, with the accident this causes, is prevented.

Estimate of the economic benefits of ESP

Economic study of truck accidents

Classification in types of damage and costs

In an economic study the costs of accidents can be divided roughly into three categories for the purposes of estimates.

(1) Direct internal accident costs (allocated directly, borne by the insurance company/those responsible)

- Personal injuries (costs to the economy, mean values from [2]):
  - Fatal injuries (EUR 1.187 million per case)
  - Serious injuries (EUR 829,000 per case)
  - Minor injuries (EUR 37,200 per case)
- Damage to property (from accident files/police estimates):
  - Vehicles (repair costs, total write-offs)
  - Loads (loss of value, destruction)
  - Infrastructure (road surface, installations, e.g. guard rails, signalling equipment)
  - Environment (leaks of hazardous materials, pollution, etc.)
  - Salvage costs

(2) Direct external accident (follow-up) costs (from estimates, e.g. from traffic loads etc., can be relatively easily estimated)

- Follow-up accidents (direct, i.e. on the same road)
- Extra fuel consumption by those involved directly and indirectly
- Downtimes for driver and vehicle
- Late delivery of the goods being transported
- Compliance with driving hours (increase of risk or costs)
- Cost for police, fire fighters, salvage crews, where not included in (1)

(3) Indirect external accident (follow-up) costs (if these occur at all, only a rough estimate is possible)

- Non-monetary real costs (effects of diversions and slow-moving traffic, in particular commercial vehicles)
  - Increased damage to buildings (pollution, vibrations, etc.)
  - General environmental pollution (contaminated air, etc.)
  - Use of roads that are not designed for heavy loads
  - Effects on (obstructions) to normal traffic
  - Indirect follow-up accidents (increased risks of accidents on diversion routes)
  - Increased vehicle wear through stop-and-go
  - Increased demand for rescue, hospital and care infrastructure
- Non-monetary mental costs
  - Reduced motivation and performance through illness/death of relatives
  - Increased stress
  - Effect on quality of life of injured persons and their relatives

The costs of the accident that was studied above were estimated for costs types (1) and (2) on the basis of the following assumptions:

Road users affected *(3(4) lane autobahn with total of 5000 vehicles/h in each direction, connecting road with 500 vehicles/h in each direction, built-up area with estimated 10,000 vehicles and 1.5 persons per vehicle)*	*65,000*
Average delay:	*2 hours*
Time cost rate per h of delay: *(from [3])*	*EUR 2.7/h*
Average additional fuel consumption *(idling, starting, diversion)*	*2.5 l/h*

This results in the following breakdown:

Personal injury (rounded down)	
(one slightly injured person [2]):	*EUR 3,500*
Damage to property	
(police estimate):	*EUR 125,000*
Fuel costs (EUR 1/l):	*EUR 325,000*
Time costs for delays	
(1.5 pers/veh. = EUR 8/veh.):	*EUR 520,000*
Total (w/o damage type 3):	***EUR 973,500***

This means that the above case resulted in internal accident costs of EUR 128,500, which are contrasted with direct external accident costs of EUR 845,000. In other words, the direct external accident costs are higher than the internal costs covered by those responsible by a factor of 5-6. The indirect external accident costs, which it is extremely difficult to estimate, are not taken into account.

Costs of accidents involving hazardous goods transporters

According to the Federal Statistics Office (BASt) [4] the direct costs of accidents involving goods traffic in Germany amounted to approx. EUR 2.4 billion in 1995. This figure includes EUR 273 million for damage to property and EUR 2.18 billion for personal injuries. Accidents involving hazardous goods transporters have a share of about 1.2% of the direct costs (i.e. around EUR 28 million), whereby the share of damage to property is four times as high than with goods traffic as a whole.

Bickel/Friedrich [5] calculate external costs of accidents of between EUR 1 billion and EUR 2.9 billion per year. If we set the share of hazardous goods transporter accidents in the external costs at the same 1.2% referred to above, this results in external costs of accidents involving hazardous goods transporters in the range of EUR 12 million to EUR 34.8 million per year.

If we correct these data given roughly constant accident figures with current cost rates (for personal injuries in particular costs rose by approx. 60% between 1995 and 2001 [2]), this results in approx. EUR 45 million per year for costs type (1) and with an applied annual rate of increase of 3% for external accident costs in type (2) a margin of EUR 14.6 to EUR 42.4 million per year. The estimated sum for the total damage caused by traffic accidents involving hazardous goods transporters is then between EUR 59.6 and EUR 87.4 per year. The indirect external costs are not taken into account here.

ESP system costs

At present, the total number of registered commercial vehicles over 7.5 t in Germany is approx. 370,000 [6]. The share of hazardous goods transporters is about 4%, i.e. 14,800 vehicles. Current extra costs for ESP for the final customer of approx. EUR 1,500 per vehicle mean a total of EUR 22.2 million is required to fit all hazardous goods transporters registered in Germany with ESP. If the service life of a vehicle of this type is set at 10 years, there remain additional costs per year for ESP of EUR 2.22 million.

Potential for avoiding costs by using ESP for hazardous goods transporters

According to a study carried out under Prof. Langwieder at the Institut für Fahrzeugsicherheit in Munich [7] around nine percent of accidents involving heavy commercial vehicles could be avoided through the use of ESP, or the severity of their consequences could be clearly reduced. Assuming that this also applies to accidents involving hazardous material transporters, this results in a cost savings potential of approx. EUR 5.3 - 7.8 million/year. The indirect external accident costs are not contained here either, i.e. the estimate is on the low side.

If we take into account the equipment costs of, at present, EUR 2.22 million/year, assuming, for the sake of simplicity, a constant vehicle population, from the aspect of the economy as a whole there is a savings potential of EUR 3.1 - 5.6 million/year through the wide-ranging use of ESP with hazardous material transporters. This amount will increase greatly in the future because, on the one hand, accident costs are increasing further (with personal injuries the growth in the last seven years was nearly 60%) and, on the other hand, vehicle populations will increase greatly [8].

Extrapolation to general goods transport

After correction of the direct accident costs (approx. EUR 2.4 billion in the year 1995) shown above and the external accident costs in goods traffic shown there (between EUR 1 and EUR 2.9 billion/year) given roughly constant accident figures with current cost rates, the result is approx. EUR 3.8 billion/year for costs type (1) and EUR 1.2 - 3.5 billion/year for the external accident costs in class (2). This makes annual total accident costs in goods traffic of between EUR 5 billion and EUR 7.3 billion.

If we use the potential accident prevention rate through ESP of 9% estimated in [7], the result is a savings potential for the economy as a whole of EUR 450-657 million/year. This is contrasted with equipment costs in the amount of EUR 55.5 million/year for ESP, i.e. below the line there are po-

tential savings for the economy as a whole of approx. EUR 395-602 million/year through the wide-range use of ESP in heavy goods vehicles in Germany alone.

Summary

The benefits of ESP were made clear with an HIL simulation using real accident data. The articulated tanker that tipped over in this accident would not have done so with ESP, i.e. equipping the tractor unit with ESP would have prevented damage to the economy totalling EUR 973,000.

An extrapolation of the effects of ESP to all hazardous goods transporters in Germany with the help of statistical data results in a savings potential for the economy as a whole of EUR 5.3 - 7.8 million/year, of which EUR 3.1 - 5.6 million/year still remain after taking the equipment costs of EUR 2.2 million/year into account.

If the estimate is extrapolated to all goods vehicles, the result is a savings potential for the economy as a whole of EUR 395 - 602 million/year through the wide-ranging use of ESP in heavy goods vehicles in Germany alone.

The savings potential as a result of the estimates that were carried out should be regarded as erring on the low side, because, on the one hand, not all costs to the economy could be taken into account (costs type (3) is missing) and, on the other hand, an increase in damage resulting from accidents can be expected from the probable growth in goods traffic in Europe (by 50 % to 2010 [8]).

Bibliography

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