Conclusions on the management of road tunnels after six years of application of the directive 2004/54 of the EC

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Abstract

Since the road tunnel directive 2004/54/EC came into effect, and its transposition to the norms of the countries members of the European Commission (EC), the budget for projects of adaptation of tunnels in service has been increased, focusing in the investment in facilities. The experience on the application of this norm, the analysis of accidents and incidents occurred and the simulations that were done, have allowed us to reach interesting conclusions from the point of view of the management of the infrastructure. In the majority of the analyzed cases, there were detected faults of effective coordination with the services of civil protection (firemen, traffic police, ambulances, etc.). Clearly this mistakes should be easily rectifiable with organization of coordination meetings and realization of low cost joint exercises (without cutting the road or any other interference with the tunnel).
The most important mistakes are due to:

- Lack of personal training from the control centre.
- Inappropriate programing of the automatic mechanisms in case of emergency.
- Lack of information for the users. Accident victims and other vehicles affected by an accident and behaviours extremely negligent that, in many occasions, cause a higher risk than the own accident.

Why do these mistakes happen?

Fortunately the personnel of the control centre, despite having the appropriate theoretical education, has few opportunities of putting into practice their knowledge, finding a lot of cases in which the operator of the control centre hadn't have to act before an emergency for over five years. On the other hand, by not producing almost any accidents, many operators do not maintain the facilities for detection and control of incidents appropriately. The same way the users of the infrastructure don't attend the signaling or the indications of the speaker, so they act by survival instincts.

How to fight against these mistakes?

- With institutional campaigns of information and awareness of the drivers.
- With serious labour from the control administration of the operators of the infrastructure, giving more power to the road tunnel safety officer.
- Concentrating and reducing the number of control centres, whenever possible.

In regard to this last point, the technology of wireless data transmission has progressed so much in the last few years, that it allows a remarkable reduction of expenses and issues about the location of the control

centres. It would only be essential to maintain, close to the tunnels in service, the necessary means of exploitation and maintenance, finding control centres separated by long distances.

Keywords: road tunnels, safety in tunnels, safety officer, tunnel risk management.

1. Introduction:

The Community Directive 2004/54 about tunnel safety in trans-European road network (on minimum safety requirements for tunnels in the Trans-European Road Network) is a norm developed because of the special importance of the accidents occurred in several tunnels throughout the past years, specially the accidents from the Mont Blanc tunnel in 1999 with 39 deaths, the San Gotardo tunnel in October 2001 with 19 deaths, among others.

Within the recitals of the Directive the special importance that the European Union gives to the security along the Trans-European road network is found. The tunnels which length is superior to 500m involve they are important means of communication that need to be maintained in adequate security conditions. But, what is achieved with the application of this directive? Is it possible to reduce the number of accidents? In our opinion, the safety in a great length tunnel is fundamentally conditioned by its section and route. The other measures are important to minimize the consequences of a possible accident and, therefore, are not definitive to keep the tunnels from the trans-European road network free of accidents.

On the other hand, the application of this norm forces many old tunnels implementing accident detection facilities, firefighting, ventilation and obsolete evacuation, to update. The invesments necessary to reach the security levels proposed, are very high. These investments are barely viable due to the economic crisis we find ourselves in, and even more if we take into account the low real accident rate in unidirectional tunnels, which are almost the total of spanish tunnels belonging to the Trans-European road network.

Great length tunnels have control centres, in which everything that happens in them is watched and the answer and acting before any incident or accident is organized and controled. It is vital not to forget that a great control centre is not usefull without the qualified staff ruling it.

The directive bets for good facilities with a fine infrastructue and a vital coordination with the emergency services.

The question which answer seems to us the most important, is the following: Will these investments really improve in a significant way the security of our tunnels?

2. Analysis of the Directive 2004/54/EC:

Among the recitals of the directive, there are two that come out especially important:

Tunnels security requires a series of related measures, between other aspects, such as the geometry of the tunnel and its design, the security equipment, including the road signage, traffic management, professional training of the emergency members, incident management, the information directed to the users about the best way to behave in a tunnel, as well as a better communication between the responsible authorities and the emergency services, such as the police, firemen and rescue teams.

As the works of the Economic Commission for Europe of the United Nations have shown, the behavior of the users of the roads is a decisive aspect in tunnel safety.

We understand that nobody doubts that the main and most important factor when an accident happens is "the human factor". Let's remember, for example, as in the fire of the Mont Blanc Tunnel, a truck driver entered the tunnel with the load already in flames and what produced the catastrophe was to stop the vehicle in the inside of the tunnel and not outside. Imprudence is only minimized by the education and awareness of the users.
The Directive tries to improve the infrastructures, superstructures and management of tunnels.

Inside of its annex I, the security measures that a tunnel must have are described, mainly in function of, its length, direction and traffic. It describes the minimum facilities, the route and section conditions, ventilation, emergency exits, communication systems, etc.

It identifies obligations and responsibilities of each of the agents that intervene in the construction, exploitation and management of the tunnel. It mainly creates two new figures. The one responsible for the safety of the tunnel (safety officer) and the inspection entity.

The responsible for the safety of the tunnel has as main obligation, coordinate the entire preventive and safeguard measures, to guarantee the safety of the users and the staff. Its regulatory functions are:

a. Ensure the coordination with the emergency services and participate in the preparation of the action plans.
b. Participate in the planning, put into practice and evaluation of the emergency operations.
c. Take part in the definition of the security plans and in the specification of the structure, equipment and functioning, both new tunnels and the modification of existing ones.
d. Verify the professional training of the tunnel staff as well as the emergency services and participate in the organization of drills that will take place regularly.
e. Advice when authorizing the structure, equipment and the functioning of tunnels.
f. Verify the maintenance and repairs of the structure and the equipment of the tunnels.
g. Take part in the evaluation of any important incident or accident.

The creation and development of professional firms in this new area will take coupled the substantial improvement in the management of tunnels, the specialization in coordination between tunnel exploitation technicians and emergency services, the improvement in drills organization and a new objective vision for the best application of the Directive.

The inspection agencies will carry out inspections, evaluations and tests.

The directive makes it very clear in its recitals which are the objectives of the norm, The easy part is to focus in the implementation of facilities and the complicated one is to deepen in the necessary coordination with emergency services, professional training of the staff, testing and effective drills, etc.

3. Drills:

The experience in the analysis of the accidents in general and those particularly occurred in tunnels, is that these accidents are the result of the addition of many things that could go wrong and went wrong.

This is the reason why it is fundamental the professional training of all the conservation staff, as well as firemen and civil protection personnel, etc.

In any accident in a tunnel, it is highly important to act in the shortest time possible. The experts sustain that the first ten minutes are the most decisive. This has to be the aim of the trainings and drills. The main facilities available in tunnels have three main goals, detection of accidents or incidents, ventilation and firefighting. None of them is focused to prevent accidents. All of them are to minimize the consequences of accidents and the time of intervention. Nevertheless it is necessary to think about the reasons why, almost every time, the emergency services receive the first alarm from a mobile call by a user of the tunnel.
For further analysis of the accident of the Mont Blanc tunnel, in this one practically everything that could go wrong went wrong. The Belgium truck driver caused the accident when he abandoned his truck in flames in the middle of the tunnel, He said that He did not notice the fire until the other drivers started to switch the lights, blinking, but this is not the worst. He did not park in the places designated for that purpose on the side of the tunnel, but he stopped in the middle of the road and when He realized that there was nothing He could do, He started running towards Italy.

In this grave accident the security and rescue devices failed, one after the other: delay in raising the alarm and to prohibit the entry of new vehicles in the tunnel, insufficient means in the struggle against the great fire (with temperatures above a thousand degrees Celsius) and lack of knowledge to use them, delay in alerting the firemen, radio equipments damaged, and the list of mistakes continuous.

Also, a fatal mistake committed by the Italian responsible of the extraction system and ventilation had to be added, instead of activating the function of smoke suction, He activated the opposite function to the maximum, a ventilation that stir the fire and pushed it towards the French lifeguards. This much commented mistake happened very often in the incidents analyzed since the entry into force of the Directive. It is really complicated to make transcendental decisions in a real emergency and any other mistake could cost a lot of lives.

In most of the drills analyzed, as what happen in Mont Blanc, lack of effective coordination with the services of civil protection was detected (firemen, traffic police, ambulances). Clearly these mistakes should be easily rectifiable with organization of coordination meetings and realization of low cost joint exercises (without interfering the traffic throughout the tunnel).

But the most important faults are due to:

→ **Lack of training of the control centre staff:** When the alarms and the system of incident detection went out, the operator usually hesitates and takes between 2 and 4 minutes in focusing in the emergency situation and to start to apply the established protocols. Despite the fact that in some cases board drills were performed, that is to say, without real emergency, professional training never makes up for the lack of experience.
→ **Inadequate programming of the automatic equipments in case of emergency:** In several drills and incidents analyzed the programmed emergency card was not the appropriate, especially regarding the ventilation. The lack of leadership during a real accident is solved during the drills and when it is necessary to force the automatic system it is usually done correctly. In several incidents there were mistakes detected when activating the protocol established.
→ **Lack of information of third parties:** Vehicles affected by an accident and drivers with negligent behavior, in many cases generates a higher risk than the accident itself.

Why do these faults happen?

Luckily the control centre staff, despite having the correct theoretical education, has few opportunities to put into practice its knowledge, finding numerous cases in which an operator of the control centre has not had to act before any emergency situation in a period longer than 5 years.

On the other hand, by not having many accidents, many exploiters do not maintain adequately the detection and incident control facilities. In this particular case the since the application of the new Directive there have been an important improvement, establishing numerous maintenance control protocols. Also, the contribution of the emergency services through the cooperation undertaken has been important. Many times the firemen suggest improvements in little details related to the maintenance of the hydrants or with protocols of tunnel access that turn out to be vital to minimize the consequences of an accident.
In the same way the users of the infrastructure, in many cases, attend neither the signaling nor the indications given by the speaker and they just act by their survival instincts. In two incidents occurred last year it can be seen in the cameras like several users do not respect the variable signaling that prohibits the circulation, and move towards the accident site, to exit the tunnel in opposite direction and with a high risk of running over the emergency personnel.

How to fight these mistakes?
- With institutional campaigns of information and awareness of the drivers.
- With serious works from the exploiters control administrations of the infrastructures, giving a higher authority to the Road Tunnel Safety Officer. Even when the directive requires the tunnel exploiter, and given that the maintenance of a tunnel is rather expensive, the figure of the safety officer is fundamental because it brings experience and collaboration to solve problems, but at the same time makes the exploiter fulfill its obligations.
- Concentrating and reducing the number of control centers, whenever this is possible. Experience shows us that it is of vital importance the proximity of conservation, exploitation and emergency services to the tunnel, but not necessarily close to the control center. If the number of control centers is reduced, the cost of construction and maintenance could be minimized, a better professional training of the centers operators could be achieved and ultimately the performance before an accident would be improved.

4. Conclusions and research lines.

After six years of application of the Community Directive about tunnels safety and its application in Spain, the progress in the management of tunnels has been significant. After a few years of adaption with great budgets, and because of the crises we are submerged in, all the efforts will be focused to the imminent improvement of tunnel management through the figure of the Tunnel Safety Officer. In the majority of tunnels the existing facilities are sufficient for the early detection of accidents and incidents and with an adequate management could be enough. From our point of view and based on our experience, there are three the measures that would suppose a substantial improvement in the application of the Directive. They are the following:
- Institutional campaigns of information and awareness of drivers.
- Serious works in the exploiters control administration of infrastructures, giving a higher authority to the Road Tunnel Safety Officer.
- Concentrate and reduce the number of control centers, whenever possible.

For future investigations, the cost and compilation of optic fiber network installation to send signals from the tunnel to the control center, forces to have fixed centers. Nevertheless the advance in the last years in velocity and quality of wireless signals makes us consider the

possibility to keep researching this field, so that in case of occurring important accidents, these signals could be sent, not only to the control centers, but to firemen and other control centers with more expertise in determined emergency situations, directly to the responsible of the acting, etc.

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