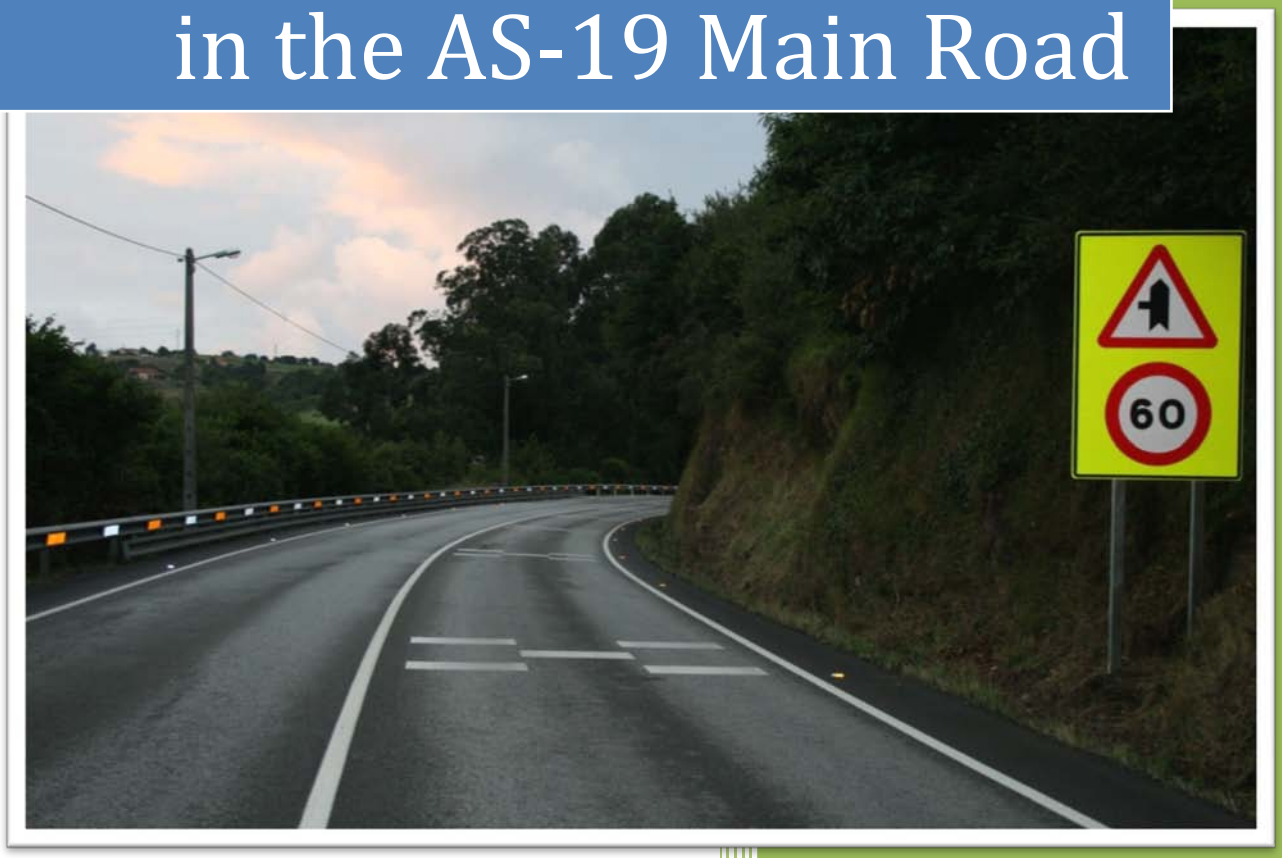
STARS Project

European Road Safety Project in the AS-19 Main Road



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Sponsors

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SEPRINSA
Señalizaciones del Principado, S. A.

3M España

ABSTRACT

This Project emerges in one of the actions of the European Transport Safety Council: the STARS Project. The objective is to achieve a reduction of the speed in a stretch of a road using an economical and easy-to-implement campaign.

It was searched a suitable stretch to carry out the campaign. It was done a statistical study of more than 200 km of the most important roads in the central area of Asturias. These previous study has been complemented with field investigations and consultations to Road Safety experts.

The selected stretch is located in the Kilometre Point 6 of the AS-19 Main Road. This road is very important, because it joins the cities of Gijón and Avilés. Furthermore, there are lots of industries nearby that make the traffic flow dense in this road. The place chosen is characterised by the existence of a crossing that gives entrance to Falmuria's Industrial Park. There are also two bus stops and the visibility is low. All these characteristics have made this stretch the most suitable place to implement the campaign in.

The campaign has consisted on using high visibility elements that catch the drivers' attention and make them pay more attention while driving through this stretch. There have been placed two fluorescent reflective high visibility panels, together with white transversal alert road markings. The delineation of this stretch has been improved by placing "cat's eye" road studs and reflecting barrier studs. A brand new delineation system has been placed in the metal barrier of the most dangerous stretch.

This campaign has been supported by local authorities that have given advice and support during the different stages of the project. It was also achieved an agreement with two private companies: SEPRINSA and 3M España. They have contributed with all the material and the labour needed.

It has been carried out a speed statistical study. It was measured the speed of more than 32000 vehicles during three periods. After the study, it was concluded that it has been achieved a reduction of 9.2 % in the speed with the actions carried out in this project.

This project has had a great impact in the media. The news of this project has been published in the most important journal in Asturias, called "*La Nueva España*". Furthermore, this project has been spread through a Facebook page that had the support of the Official Superior Industrial Engineers Association of Asturias and León.

ACKNOWLEDGEMENTS

There have been several people and organizations that have collaborated with this project. We want to show our gratitude because they have made it possible to carry out the campaign.

We want to say thank you to all the road safety and road management experts from the local authorities ("*Dirección General de Carreteras, Transportes y Asuntos Marítimos*"): Mr. Carlos Rayón Martín, Road Safety Manager; Mr. César Orejas Fernández, Maintenance Service Manager; and Mr. Juan Manuel Fernández García, Negotiator Manager of the Central Zone of Maintenance. They all helped and gave good advice at the time to take decisions. We also want to thank Mr. José Ángel Pérez Morandeira, Computer Operator and Cartography, because of his availability and collaboration to make the speed measures, even while he was on holiday.

We also want to thank Mr. Manuel José Suárez López (Manolo), General Manager of SEPRINSA. He involved a lot with the project and contributed with the labour needed. We also appreciate the time he spent and his dedication, adapting his hours to the hours that were required by the project. That made that all the measures were implanted in the suitable moment.

The last – but not least – person we want to thank is Alberto Costoyas Sánchez, Sales Delegator of Road Safety Systems, from the company 3M España, S.A. He introduced this project to an international company like 3M and contributed by giving the "cat's eye" road studs and the new crash barriers delineators, the 3M DLS.

CONTENT INDEX

CONTENT INDEX

DESCRIPTIVE MEMORY

1. INTRODUCTION

Speeding has been and is a reason of many road accidents. It is proved that, the more you speed, the more possibilities of suffering an accident you will have. In addition, the faster you go when you have an accident, the more serious the consequences will be.

Since a long time, governments have been carrying out different kinds of campaigns to try to raise and to make aware the drivers. At the same time, they have also tried to look for new ways for putting up road signs and for designing the routes, so that these measures produce in the drivers a tendency to moderate their speed.

In the present report, it is carried out a careful selection of a few specific stretches of road. It is showed the current situation in each of them and it is proposed possible measures to implant. These measures have the purpose of achieving, once they are put in practice, a reduction of the average speed of the vehicles that flow along the stretches.

This project is born as an initiative created by the European Transport Safety Council (ETSC), known as STARS Project. A sum of 22 people – that form 11 workgroups – have been selected between candidates of 6 countries of the European Union. Currently, there are only two groups in Spain: one of them is in Asturias, which is the author of this document, and the other one in the Valencian Community.

Illustration 1: Participants of STARS Project in the European Parliament.

2. BACKGROUND

2.1. European Transport Safety Council (ETSC)

The European Transport Safety Council (ETSC) is a Brussels-based **independent non-profit making organisation** dedicated to reducing the number of deaths and injuries in transport in Europe.

Founded in 1993, ETSC provides an **impartial source of expert advice** on transport safety matters to the European Commission, the European Parliament, and Member States. It maintains its independence through funding from a variety of sources including membership subscriptions, the European Commission, and public and private sector support for various activities.

ETSC seeks to **identify and promote effective measures** on the basis of international scientific research and best practice in areas which offer the greatest potential for a reduction in transport crashes and casualties. It provides factual information in the form of scientific reports, fact sheets and newsletters in support of high safety standards in EU harmonisation, the take up of best practice and transport safety research. ETSC also organises several conferences yearly, including the *"European Transport Safety Lecture"* and the *"European Transport Safety Lunches"*.

★★★★★★

ETSC is an independent non-profit making organisation.

It seeks to identify and promote effective measures on the basis of international scientific research.

★★★★★★

2.2. STARS Project

STARS is a European project on speed by the European Transport Safety Council. STARS is an 18 month project which aims at mobilising transport research into speed management to demonstrate how excessive and inappropriate speed can be reduced through existing measures. The meaning of STARS is "STudents Acting to Reduce Speed".

The main objective of STARS is to run concrete actions that can reduce speed through the work of students. In all, 22 people selected between 6 countries (Germany, Czech Republic, France, Greece, Romania and Spain) of all around Europe take part in this project.

STARS relies on the work of committed young university students who will be encouraged to run a local speed management action to reduce speeding through infrastructure projects or communication projects in road transport with the support of ETSC and its partners.

★★★★★★★

This project is developed inside STARS and has the support of ETSC.

The "Letter of support of ETSC" can be seen in the Annex I of this document.

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2.3. The effect of the speed in the collisions

If the speed of the vehicles were reduced 5%, the number of mortal victims would be reduced 20%.
In the EU almost 2000 lives would be saved per year.

The speed of a vehicle in a road is one of the most important elements to value. The maximum speed which is possible to run along a road in safety conditions is determined by the characteristics of the road and of the route.

In the European Union, **50% of the drivers usually exceed the speed limits**, according to information handled by the ETSC. In addition, **speeding is a possible concurrent factor of approximately a third of the accidents.**

This information is really alarming. Driving over the speed limit does that, in a situation of emergency or the appearance of an unexpected obstacle in the road, the driver has not enough time to stop his vehicle and to avoid the accident.

In agreement with the statistics of the International Forum of Transport of the OECD (Organization for the Cooperation and Economic Development), if the speed of the vehicles were reduced in 5% in the roads, the number of accidents with victims would be reduced in 10%, whereas the number of mortal accidents would be reduced 20%.

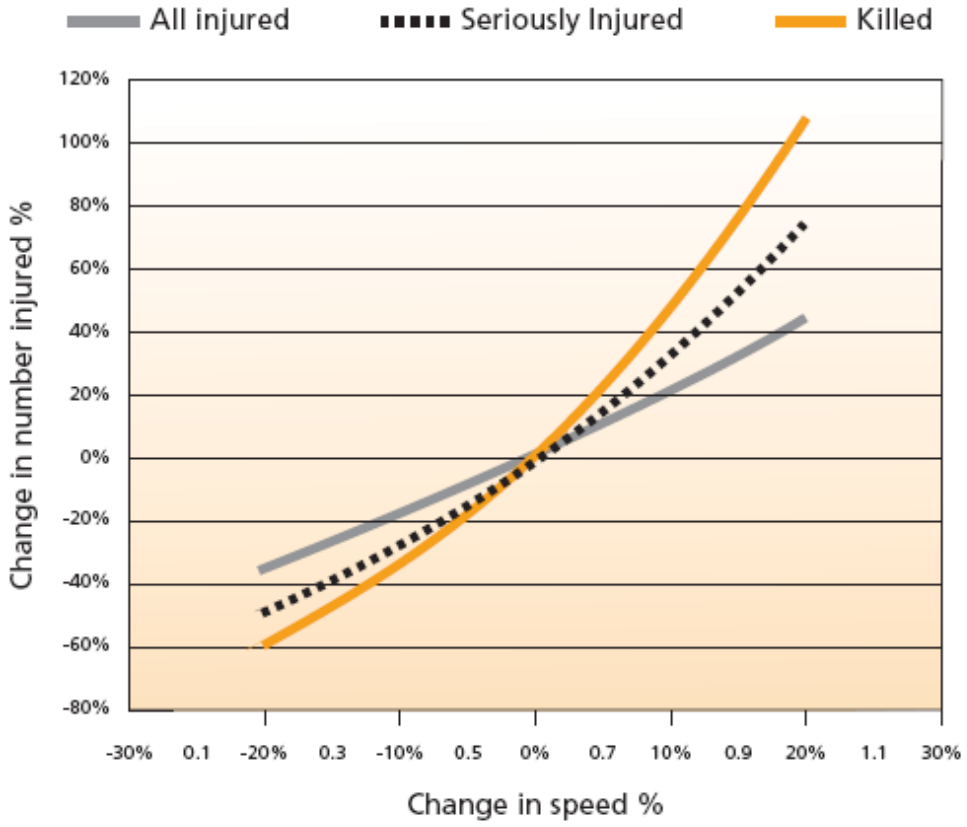


Illustration 2: Variation of accidents depending on the variation of the average speed.

3. OBJECTIVES

This project has 3 main objectives:

- First and after having seen the paragraph "*2.3.* The effect of the speed in the collisions", the great influence that has the excessive speed in the quantity and severity of the accidents, it can be presupposed which the main aim of this campaign is. It is to obtain a **reduction of the average speed of the vehicles** that are driven along a certain dangerous stretch of a road.
- The second objective is **to improve the safety in a stretch of a road** in which, statistically, there are more accidents. For this reason, a statistical study will be carried out in several roads of the central area of Asturias to being able to choose a suitable emplacement.
- STARS Project takes as reference the ETSC's philosophy, which consists of demonstrate using scientific methods, that it is possible to obtain a significant reduction of the speed, using already existing low-cost measures. For this reason, the third aim will be that the proposed **measures** must be **economic and easy-to-implement**.

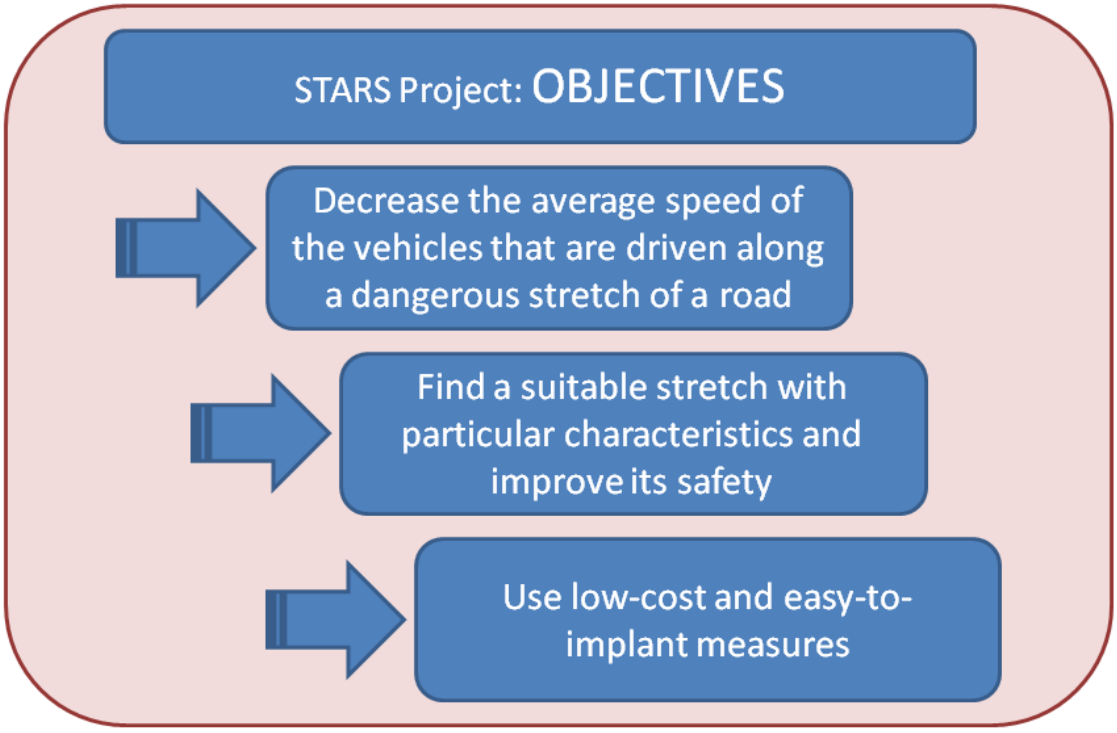


Illustration 3: Summary of the aims that we want to obtain with this project.

4. STAKEHOLDERS

Private companies and official organisms have collaborated in diverse forms. Our stakeholders made it possible to carry out this project. We have had the collaboration of the following entities:

- Dirección General de Carreteras, Transportes y Asuntos Marítimos.
- 3M España, S.A.
- Señalizaciones del Principado, S.A. (SEPRINSA).

The contribution done by each of these entities is detailed below.

4.1. Dirección General de Carreteras, Transportes y Asuntos Marítimos

The "*Dirección General de Carreteras, Transportes y Asuntos Marítimos*" is the official organism of the Government of Asturias that has the function of directing and coordinating all the functions of the Council as far as transport is concerned.

This project counted with the personal advice of technical staff responsible for Road Safety to get to know the current rules in our country. They have helped us to take important decisions and during the implementation of the campaign.

This organism has also collaborated supplying certain material to carry out the appropriate studies, for example the installation of a station to measure the speed of the vehicles along the chosen stretch.

Likewise, they have carried out workings of pruning and clearing the vegetation from the ditch, in order to prepare the stretch before becoming established the measures proposed in this project.

4.2. Señalizaciones del Principado, S.A. (SEPRINSA)

"*SEPRINSA*" is an asturian company which has the aim of commercialization, saling and placing traffic signs. They are also expert applicators regarding special paintings in roads. SEPRINSA does any other activity related with signing and marking the roads, streets, airports, parkings, crash barriers, luminous signs and gateways. This company is also committed to installing either concrete or crash barriers.

The contribution of "*SEPRINSA*" has been the following:

- Cleaning and repairing the crash barriers.
- Painting the road marking.
- Placing the pavement reflecting road studs and the crash barrier reflecting road studs.
- Manufacturing and placing the new traffic signing.
- Manufacturing the necessary platens to fix the linear delineation systems in the crash barriers, and placing those LDS on the crash barriers.
- Cleaning and painting the bus shelters.
- Paying for all the material needed that was not provided by 3M España.

Illustration 4: SEPRINSA's machine to paint the road markings.

4.3. 3M España, S.A.

"*3M España*" is committed to investigate, develop, manufacture and commercialize different technologies in order to offer innovative products and services in different areas. One of these areas is Road Safety. For more than 60 years, 3M has been at the head of the investigation of reflective road studs, with the objective of achieving safer roads.

The contribution of this company with the project has been providing part of the necessary material to carry out this campaign. The materials supplied by 3M have been the following:

- Marker Series 290 Reflecting Road Stud, for their placing in the verge of the road.
- Linear Delineation System (LDS) pieces, for their placing in the crash barrier.

5. DEFINITIONS

Kilometer Point (K.P.)

A "*Kilometer Point*" or "*milestone*" is used to define a specific hectometre of a road. It consists of a number with a decimal part, where the number informs about the kilometre and the decimal part represents the hectometre.

Stretch of accident concentration

"*Stretch of accident concentration*" is a stretch that has a risk of accident higher than the average registered in other stretches with the same characteristics. It determines the stretch with a high accident rate in comparison with similar stretches.

Black Spot

A "*black spot*" is the emplacement belonging to a road of the road network in which during a year there have been detected 3 or more accidents with victims, with a maximum separation between one and other of 100 m.

Accident with victims

In the present document, it is considered "*accident with victims*" all accidents that have the following characteristics:

- Taking place or having its origin in at least one of the following aspects: the routes or areas of the traffic legislation, motor vehicles or road safety.
- As a result of that one, one or more people are dead or injured.
- At least one vehicle in movement has to be involved.

Dead

Regarding road safety, every person is defined as a "*dead*" as a consequence of an accident if he dies instantly or in the following 24 hours.

Seriously injured

A "*seriously injured*" person is anyone injured in a traffic accident and whose condition needs more than 24 hours of hospitalization.

Slightly injured

A "*slight injured*" person is anyone injured in a traffic accident to whom there cannot be applied the definition of serious injured man.

Average Daily Traffic (ADT)

The "*Average Daily Traffic*" (ADT) is the average number of vehicles two-way passing a specific point in a 24-hour period, normally measured throughout a year.

Marker reflective road stud

A "*marker reflective road stud*" is a device of optical guiding, generally used as a complement of the road markings. It is able to reflect the most of the light through the reflective lens, in order to alert, guide or inform the users of the road.

Markers reflecting road stud could be formed by one or more pieces. They will be fixed to the surface of the pavement through adhesives or incrustation.

Return arrow

The "*return arrow*" is an arrow which is approximately located in the axis of a double way road and it points at the right. It announces the proximity of a continuous line that implies the prohibition of driving along the left side.

Transversal warning line

A "transversal *warning line*" is a device which modifies the tread of the surface of the road, using the transmission of vibrations and noises that result from its interaction with the suspension of the vehicle.

The transversal warning lines have the aim of transmitting to the driver the need of maximizing the attention due to the closeness to a stretch in which there is a higher risk.

Braking distance

The "*braking distance*" refers to the total distance that a vehicle which is obliged to a complete stop travels. It includes the distance travelled during the times of perception, reaction and braking.

The distance of perception and reaction refers to the distance that covers the vehicle with the initial speed in two seconds. The braking distance depends on the effective coefficient of friction between the tires and the road, and on the inclination of the low.

Crossing distance

The "*crossing distance*" is the length covered by a vehicle in a priority road during the time that other vehicle takes to cross the road. The crossing distance depends on the speed of the priority road, the kind of vehicle that is incorporating to the route and the total width of the lanes in the priority road.

Crossing visibility

The "*crossing visibility*" is the distance that a driver needs to be able to cross another road that intersects its route, measured along the axis of his lane. It is determined by the condition that the driver in the priority road must be able to see if another driver is going to cross the road.

Road surface marking

"*Road surface marking*" is any kind of device or material that is used on a road surface in order to convey official information or to control the traffic flow. They can also be applied in other facilities used by vehicles to mark parking spaces or designate areas for other uses.

6. CHOOSING THE LOCALIZATION

6.1. Choosing the road

To choose the most suitable place to locate the campaign, it has been carried out a statistical study of 215 km from 6 of the most important roads of the central area of Asturias. The complete study can be seen in the Annex II of the present document. In this chapter, there is carried out a brief description of the conclusions obtained in the study.

The place selected to implant the campaign is the **AS-19** Main Road. It is a main road that connects the cities of Gijón and Avilés. The itinerary of the road in ascending way according to the mileage passes through the following towns or cities: Gijón, El Empalme, Prendes, Tabaza y Avilés. A map of this road can be seen in the Annex III of this document.

Illustration 5: The main road called AS-19 is the road in which the campaign is proposed.

The AS-19 Main Road has special dangerous statistics. Some of them can be summed up in the following way:

- The road AS-19 is the one that has more number of accidents per kilometre between the 6 roads that have been studied.
- There is a stretch in the road AS-19 of only 2.3 km that concentrates almost the half (44%) of the mortal accidents happened in the whole road.

- In this stretch of 2.3 km, speeding has been the possible cause of 32% of the total accidents produced.

Besides, the AS-19 road has some additional characteristics that aggravate more its situation:

- It is an area with a lot of traffic, due to the great number of industries. This situation causes a great traffic flow in rush hours and a great fluency of heavy vehicles that make the situation more complicated. In 2010, the ADT has been 20801 vehicles in some stretches, whereas the percentage of heavy vehicles goes beyond 14%.
- There is a great number of crossings and entrances to private ownerships, due to the fact that there is a great quantity of properties and houses to which gain access directly from this road.
- It has been a traditional place with lots of groups of cyclists for years.
- There are long straights with brow of hills where drivers usually exceed the maximum speed.

After making a statistical study of the accident rate in several roads, it was chosen the AS-19 Main Road for being the road with more number of accidents per kilometer.

It is an important main road because it is in the central area of Asturias. This road joins two of the three main cities of the region: Gijón and Avilés. For this reason, the quantity of vehicles is very high. In some stretches there are more than 20000 daily vehicles.

In addition, the road AS-19 is located in the central area of Asturias and because of this the percentage of heavy vehicles overcomes 14%.

6.2. Choosing the concrete stretch of the AS-19 Main Road

The choice of a particular stretch in the AS-19 Main Road has been a process that has taken several months. First of all, it has been needed an analysis of the statistical data to detect the most troubling points. These studies have been used to make the first approximation of the possible places in which the campaign could be implanted.

For the final choice of the emplacement there have been done several field investigations to determine 'in situ' the concrete characteristics of each stretch. In addition, diverse **conversations and consults have been maintain with experts of the "Dirección General de Carreteras y Asuntos Marítimos del Principado de Asturias" and the ETSC** before deciding the place of the definitive emplacement.

The first place that was considered to do the campaign in was the stretch in which there were the majority of the mortal accidents. However, the action proposed had several disadvantages that made this location to be rejected.

It was decided to look for several troubling points and to raise possible actions to implant in each of them. With this strategy, there were found 3 points or stretches of the AS-19 road that had conditions to be able to carry out a campaign with the characteristics of the STARS Project. After doing a study of the possibilities of each stretch, and to value again these alternatives, it was decided to implant one of them.

In total, **4 alternative locations have been evaluated to carry out the AS-19 Main Road's campaign.**

FIRST PROPOSAL *(presented to authorities on the 22nd of February):*
A stretch that concentrates a high percentage of mortal victims

SECOND PROPOSAL *(presented to authorities on the 9th of June):*
Option 1: Crossing between two straights
Option 2: Stretch of straights
Option 3: Falmuria Industrial Park's crossing

Below, it is a brief summary of each of the offers that have been raised. It is possible to see more details about the rejected ideas in the corresponding annexes.

6.2.1. Proposal in the stretch with a high percentage of mortal victims

As it was said in the presentation of this section, it was initially suggested a campaign in the stretch of 2.3 km that concentrated almost the half of the mortal accidents of the whole road. This stretch is located between K.P. 9.1 and K.P. 11.4. It is possible to say that this stretch is constituted almost in its whole by a big straight of 1700 meters.

The idea that was proposed had the objective of being a simple, economic and viable solution, to be able to put it into practice. In addition, it was tried to use something completely new that could cause a great impact in the users of the road.

It was tried to carry out a campaign to raise drivers' awareness. It would inform about the danger of the stretch along where they were driving, catching their attention with a **vertical sign** with an aggressive message, like: *"Stretch with mortal victims. Do not be the next one"*. (An example of the sign appears on Illustration 6).

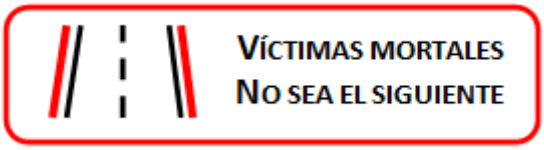


Illustration 6: Example of how the sign would be. It reads: "Death Victims, Do not be the next one".

Besides, in order to improve the effect of this sign, the message would be complemented by painting a **red line in each of the verges of the road**. In this way, the driver would be constantly informed and will remember that he is still driving along a stretch that is dangerous.

Why was this proposal rejected?

After presenting this proposal to technical experts in Road Safety, it was rejected to put into practice this initiative due to the risks that presents installing traffic sings and road markings that do not appear in the Spanish Legislation. There was the risk that these signs were not understood correctly by all drivers, producing a distraction to them.

All the information related to this first proposal can be consulted in the Annex IV of this document.

Once this first proposal was rejected, new field investigations have been done to select some areas of the road that were appropriate to carry out a campaign with the aims the philosophy of the STARS Project. Three troubling areas were detected and some actions are proposed to each of them in the following subsections.

6.2.2. Proposal in the crossing between two straights

This proposal is located in a crossing placed between two long straights, in the K.P. 9.4 of the AS-19 road. It is an opened curve that joins two big straights. For this reason, it is usual that the vehicles drive through it with a higher speed than the allowed in this stretch. In addition, there is just a crossing in the curve that gives access to several villages. This does that this is a point to which we must pay particular attention.

During the visits made to the stretch it was proved that this point is doubly dangerous, because the visibility in the exit of the crossing is limited. Provided that the vehicles drive very fast (more than 90 km/h), it is difficult to join to the road without remaining exposed to the risk of a rear-ended collision.

According to the statistics, in the last 9 years there have been 5 mortal victims in two very serious accidents in this crossing. This highlights the danger of this point. However, it must be highlighted that these accidents are isolated and due to driving in night schedule at very high speeds. This does that, in spite of being a really important piece of information, it was not so decisive at the moment of applying a campaign with the requirements of the STARS Project.

The proposals presented to improve the safety in this point of the road had as main objective to highlight the danger that is supposed at this point due to the crossing. The campaign would have consisted, basically in painting **white transverse lines**, similar to those of the type of the transverse warning lines, but without the striped that produces noise, due to the existence of several houses near the crossing. Besides, **the traffic sign of danger due to the crossing would be complemented with some yellow intermittent pilots**, to make it easy the vision of this sign.

Illustration 7: Representation of the luminous sign proposed to advice of the dangerous crossing.

Why was this proposal rejected?

This proposal was shown to the people in charge of Road Safety and of the Service of Conservation altogether with the two following proposals. This action was rejected, in favour of the proposal of the Falmuria Industrial Park's crossing. The reason to reject this point was, basically, the fact that the accidents that were given in this point were atypical (speeding, young people, during the night…) respect the rest of the accidents. According to the experts, this type of accidents would not be avoided with an initiative of the type of the one that was proposed.

All the detailed information related to this proposal can be seen in the Annex V of the present document.

6.2.3. Proposal in the stretch of straights

This stretch is located between K.P. 7.7 and 11.5. This stretch is characterized by 3 big straights with brow of hills and connected with wide curves. In this stretch it is very common that the drivers exceed the maximum speed, especially due to the length of the straights.

With the aim to improve this situation there were suggested some proposals. The first one was **to place return arrows in the axis of the road**, to warn the drivers that were overtaking that they must return to the right lane because of the proximity of a continuous line.

To avoid speeding it was proposed the placing of **signs in the straights that indicate the existence of a speed trap** and a **driver feedback sign** that shows in real time the speed and if the driver is exceeding the limit in this stretch.

Why was this proposal rejected?

This proposal has been rejected, principally, for economic reasons. The installation of a driver feedback sign needs a great investment because it is complex high cost equipment. Besides, these equipments need high expenses in maintenance because they have to be calibrated with relative frequency.

The complete information related to this proposal can be read in the Annex VI of the present document.

6.2.4. Proposal in the Falmuria Industrial Park's crossing

The crossing that gives entrance to Falmuria Industrial Park is located in the K.P. 6 of the AS-19 Main Road. This crossing is inside a stretch signposted as Stretch of Accident Concentration. During the visits done to the road, it was observed that it has some characteristics that make this crossing a very dangerous stretch. For this reason, it was decided to carry out a study of this stretch to propose a possible campaign to improve the safety.

The main characteristics of this crossing, which have been determinant to select this stretch as the most appropriated place to implant the campaign, are listed below:

- This crossing gives entrance to the Falmuria Industrial Park. Because of this, there is a high quantity of vehicles that go in and out of the industrial park, including a high percentage of heavy vehicles.

- There are lots of industries nearby, because the AS-19 road is in the central zone of Asturias. This makes the traffic very dense, especially during the rush hours.
- The visibility in the way from Avilés to Gijón of the crossing is very limited.
- The maximum speed in the crossing is the generic of the road: 90 km/h.
- There are two bus stops just in the crossing (one for each way). This aggravates more the situation.

¿Why was this place chosen to implant the campaign at?

After the study of the 4 possible alternatives, the analysis of concrete characteristics of every stretch, and the field investigations carried out to verify the current situation of each proposed stretch, it was decided – in conversations with experts of *"Dirección General de Carreteras y Asuntos Marítimos"* and with experts of ETSC – that the Falmuria Industrial Park's crossing is the most appropriate place to carry out the campaign in order to improve the safety.

In the section "*7. Campaign to improve safety on Falmuria's Crossing*", there is a more detailed description of all the particular characteristics of this crossing. Those characteristics have done that this place was finally chosen to implant the campaign in. Likewise, the actions proposed to improve the safety of this stretch are detailed in this section and it is explained step by step how the campaign has been carried out.

Illustration 8: Photography of Falmuria Industrial Park's crossing.

7. CAMPAIGN TO IMPROVE SAFETY ON FALMURIA'S CROSSING

7.1. Location: Falmuria Industrial Park's crossing (K.P. 6.0)

Illustration 9: View from satellite of Falmuria Industrial Park's crossing (K.P. 6.0).

This crossing is located in the **K.P. 6.0** of the main road AS-19, giving entrance to **Falmuria Industrial Park**, in **Prendes town**. This crossing is in a stretch of accident concentration. During the field investigations, there were detected several characteristics that make this stretch the most suitable to carry out the actions of this project. These characteristics are detailed in the next section, about the "*Situation before the implementation of the campaign*".

The Illustration 9 shows an image taken from satellite, in which the crossing can be seen. In the Illustration 10, it can be seen a photograph of the crossing, looking in the way to Avilés. The Illustration 11 shows another photograph of the crossing, looking in the way to Gijón. Both photographs have been taken before starting any action.

Illustration 10: Falmuria Industrial Park's crossing, looking on the way to Avilés.

Illustration 11: Falmuria Industrial Park's crossing, looking on the way to Gijón.

7.2. Situation before the implementation of the campaign

The crossing at the K.P. 6.0 is located in a stretch with **heavy traffic flow**, especially during the rush hours. This is particularly due to the amount of nearby industries, such as Arcelor Mittal's huge iron and steel industry or Aboño's coal-fired power station. Furthermore, as this crossing gives entrance to Falmuria Industrial Park, there are always lots of heavy vehicles driving in and out of the Industrial Park.

During the field investigations, it has been observed that it has several dangerous conditions that make this stretch suitable to be the one to locate the campaign in. The main characteristics that had this intersection before the implementation of the campaign are explained below:

- The vehicles used to pass by this crossing at **high speed**, imperilling not only their own safety, but also other driver's safety. In this crossing there was not any speed limit. The maximum speed in this crossing was the same than in the rest of the road: **90 km/h**. This is a piece of information quite remarkable, especially considering the following information:
    - The **visibility in the way from Avilés to Gijón is limited**. On joining to the AS-19 main road from the Industrial Park, the maximum visibility looking on the way to Avilés is only 165 metres.

Illustration 12: The bus stop on the way Avilés-Gijón is located after a curve, where the visibility is limited.

    - There are two **bus stops** (one in each way) just in the crossing. One of the bus stops is especially dangerous because it is located after a curve. When a coach is making a stop, the limited visibility and the very little reaction time that

drivers have, make it easy to have an accident. In the Illustration 12, it can be seen how close to the curve is the bus stop located on the verge of the lane that goes from Avilés to Gijón.

In the next section of this Project it is calculated the maximum speed suitable to this crossing, according with the visibility distances and applying the Spanish Regulation "*Norma 3.1-IC. Trazado, de la Instrucción de Carreteras*".

- It is important to remark the situation of the vertical traffic signs of this crossing. There is a traffic sign in each way that warns about the danger of a crossing. However, the traffic sign in the way to Gijón hardly enhances. Many drivers can straight pass this sign. This is because the traffic sign is placed in the curve and cannot be seen until the driver is very close to it. Furthermore, although it is not the general situation, when the weeds grow it is even more difficult to see this traffic sign. The conditions of this traffic sign before the start of the actions of this campaign can be seen in the Illustration 13.

Illustration 13: Traffic sign before the start of the campaign.

- The conditions of the road markings are another point to remark. **The lines that delimit the lanes and the crossing are almost removed.** This is because this crossing has a high flow of lorries and heavy vehicles due to the surrounding industrial area. In this stretch, the ADT is about 6000 vehicles, with a high percentage of heavy vehicles. Moreover, there is a considerable amount of lorries that transport coal to a nearby

coal-fired power station. Altogether gives a great importance to the coal dust and the dirt in this stretch, which is seriously affecting the road markings.

As it can be seen in the Illustration 14, the white line that delimits the left verge and the continuous line of the axis of the road are almost cleared at the crossing.

Illustration 14: In this photo it can be seen the conditions of the road marking before the campaign.

The statistics in this crossing confirm that this crossing is a dangerous stretch in which it is important and necessary to carry out some actions, in order to avoid dangerous situations and crashes to continue occurring in this crossing. Having a look at the last 10 years statistics, it can be checked that **this stretch has been a stretch of accident concentration almost every year.** What is more, in the last statistics, which refer to the year 2010, this crossing has been a stretch of accident concentration again.

The next paragraphs give a brief description of the most serious accidents that happened in this intersection during the last 4 years:

- Wednesday, 13/09/2006, at 11:50. There was **a span out of the road without collision, with an overturn toward the right side of one of the vehicles**. The vehicles in the accident were **a lorry with trailer and a car**. The accident took place in broad daylight. The weather was good and the asphalt was dry and clean. The causes of the accident could have been **a lapse of concentration and speeding**.
- Saturday, 03/03/2007, at 10:15. There was **a rear-end collision,** between **a van and a car**. As a consequence there were **3 slightly injured people**. The accident took place in broad daylight. The weather was drizzle and the road was wet. The causes of the

accident could have been **a lapse of concentration and breaking the road safety regulations.**

- Friday, 05/12/2008, at 11:00. There was **a front lateral collision**, between **a lorry with trailer and a car**. As a consequence there was **one slightly injured person**. The accident took place in broad daylight. The weather was drizzle and the road was wet. The cause of the accident could have been **speeding**.
- Saturday, 30/12/2007, at 23:40. There was **a crash of a car into the ditch**. As a consequence there was **a seriously injured person and another slightly injured**. The accident took place during the night (insufficient lighting). The weather was good and the asphalt was dry and clean. The causes of the accident could have been **a lapse of concentration and speeding.**
- Wednesday, 09/02/2011, at 08:20. There was **a rear-end collision,** between **a van and a car**. As a consequence there were **2 slightly injured people**. The accident took place at dawn. The weather was good and the road was dry and clean. The causes of the accident could have been **a lapse of concentration and breaking the road safety regulations.**
- Wednesday, 16/03/2011, at 19:15. There was **a front lateral collision,** between **two cars**. As a consequence there was **one slightly injured person**. The accident took place at dusk. The weather was drizzle and the road was wet. The cause of the accident could have been **a lapse of concentration.**

The conclusions after seen the most serious accidents that have taken place recently are:

- *In 5 out of 6 accidents,* ***speeding or a breaking the road safety regulations*** *could have been the cause of the accident.*
- *In 5 out of 6 accidents, a* ***lapse of concentration*** *could have been the cause of the accident.*
- *3 accidents took place in broad daylight and the other 3 during the night or with poor lightening conditions.*
- *3 accidents took place with the asphalt dry and clean and the other 3 took place in wet conditions.*

The accidents happened in this crossing, sometimes have been so important that appeared in the local press. There are two examples below of two pieces of news that appeared in two different newspapers: "*La Voz de Asturias"* and "*El Comercio*".

La Voz de Asturias · Archivo

AVILÉS

Dos heridos graves en sendos accidentes

INCIDENCIAS EN LAS CARRETERAS DE LA COMARCATres personas más resultaron heridas leves en uno de los siniestros.

19/01/2006 06:10 / A.A.

El nuevo tramo de la Autovía del Cantábrico, inaugurado recientemente, a su paso por el municipio de Corvera ya ha padecido su primer accidente en el que una persona ha resultado herida grave y tres leves, según informan fuentes del 112 del Principado de Asturias.

El siniestro se produjo al colisionar dos vehículos, un Audi conducido por J.F., que resultó herida grave y que precisó ser excarcelada por efectivos de Bomberos de Asturias, y un monovolumen Chrysler, pilotado por A.F.F., que resultó herida leve, al igual que su hijo S.C.F., de dos años de edad. También resultó herido un ocupante del primer vehículo, J.V.B., con heridas de carácter leve.

En el accidente intervinieron efectivos del SAMU, que trasladaron a la herida grave en UVI-móvil al Hospital San Agustín, de la Guardia Civil y de Bomberos de Asturias con base en Avilés.

COLISION EN PRENDES En la tarde de ayer se produjo además otro accidente de tráfico, esta vez en Carreño, cuando R. B. N., conductor de una furgoneta de la marca Nissan y matrícula O-9103-BN, resultó herido grave tras colisionar con un camión de la marca Renault y matrícula O-7016-BD, cuyo conductor, J. A. M., resultó ileso.

El incidente tuvo lugar en la carretera autonómica AS-19, punto kilométrico 6, en las inmediaciones del Polígono Industrial de Prendes, según informan fuentes del 112 del Principado de Asturias.

El accidente se produjo a las 17.00 horas de ayer y en el mismo intervinieron efectivos del SAMU y de Bomberos de Asturias, con base en Avilés, quienes tuvieron que excarcelar al conductor de la furgoneta, ya que quedó atrapado tras la colisión.

Illustration 15: Piece of news published on 19th of January of 2006, about an accident happened in this crossing, between a van and a lorry. One person was seriously injured.

ELCOMERCIO.es

Herido un conductor al chocar el coche contra un guarda-raíl en Prendes

Agencia EFE

Oviedo, 9 feb (EFE).- Un hombre ha resultado herido hoy al chocar el coche que conducía contra un guarda-raíl tras salirse de la carretera AS-19 a la altura del kilómetro 6, en Prendes (Carreño), informa el 112.

El herido ha sido trasladado al Hospital de Jove de Gijón con contusiones de carácter leve y ha tenido que ser ayudado por los bomberos para salir del vehículo.

El Centro de Coordinación de Emergencias del 112-Asturias ha recibido el aviso pasadas las ocho y veinte de la mañana a través de una llamada en la que explicaban que un vehículo había colisionado contra un guarda-raíl y que su conductor no podía salir de su interior.

Illustration 16: Piece of news published on 9th of February of 2011. A man has been slightly injured after crashing against the crash barrier while he was driving his car along the crossing.

7.3. Approach to the campaign

This section shows in detail the proposed actions to carry out the campaign. These actions have been proposed after field investigations and studies about the situation of the stretch.

Given that **the causes of the more serious accidents could have mostly been speeding and lapses of concentration**, it will be tried to propose **actions that make drivers to reduce their speed and to keep concentrated while driving through this stretch**. In this way, the danger of this crossing and the risk of accident will be reduced.

As it will be seen, **the actions proposed are intimately connected to each other. It has been done a research, so the actions complement one another and they can be considered as a whole** whose aim is to improve the stretch's safety in all the different conditions. All the actions proposed are listed and explained in detailed below.

7.3.1. Actions to prepare the stretch

First of all, **several actions to prepare the stretch** are proposed. These actions can be considered as a complement of the campaign, because they are maintenance actions that were needed due to the situation of the stretch.

In order to avoid these actions to have an influence in the statistical studies of this project, these actions will be done before the other actions that are considered a part of the campaign. This will be shown later in this document, in section "*7.5. Execution of the campaign*". The actions relating with the maintenance of the stretch are the listed below:

- **Pruning the weeds of the ditches**. This was a necessary action due to the conditions of the vegetation. The pruning of this stretch was brought forward in order to adapt to the times required by the project.
- **Painting the road markings**. It was necessary to repaint the horizontal markings. The stretch painted was approximately the stretch between the two traffic signs that sign the crossing. Taking as a reference the lamppost located at the traffic island at the middle of the crossing, it is necessary to paint 210 m in the way to Gijón and 260 m in the way to Avilés. So, it will be necessary to paint **a stretch of about 470 m**. Moreover, the bus shelters will be cleaned and painted, and the bus stop will be marked with yellow zigzag lines.
- **Cleaning and repairing the crash barriers**. The crash barriers needed to be cleaned with pressurized water, because they were very dirty due to the heavy flow of vehicles. It was also necessary to change some of the barriers that were damaged because of some of the crashes.
- **Replacing the spoiled or broken traffic signs**. Some of the traffic signs were spoiled due to crashes. Those traffic signs were bended or even broken. All the traffic signs that were not in good conditions have been replaced.

7.3.2. Calculation of the maximum speed

The first real action in this stretch – apart from the maintenance actions that were necessary to be done –, aims **to establish the right speed limit, according to the characteristics of this stretch**.

The limit of maximum speed must be calculated according to the Spanish Legislation. The regulation used to calculate the speed limit was the "*Norma 3.1-IC, trazado, de la Instrucción de Carreteras",* approved in the ORDER of 27th of December, 1999.

According to this regulation, the maximum speed in a crossing must be calculated depending on the crossing distance and the crossing visibility.

The crossing visibility is 163 metres. This length has been measured depending on the distance that can be seen from the stop at the incorporation to the AS-19 road (view Illustration 17). The crossing distance can be measured using an orthophoto, as it can be seen in the Illustration 18.

Illustration 17: Visibility distance while trying to incorporate to the AS-19 road from Falmuria Industrial Park.

Illustration 18: The crossing distance can be measured using an orthophoto, proving to be 163 m.

Knowing that the crossing distance is 163 m, it is possible to calculate the suitable maximum speed to the crossing. The maximum speed of the preferential road can be calculated using the following expression:

$$V = \frac{D_C \cdot 3.6}{T_C}$$

Where:

- V is the maximum speed of the preferential road, measured in km/h.
- D_C is the crossing distance in metres (163 m).
- T_C is the time in seconds that the vehicle takes to complete the whole crossing manoeuvre.

The value of T_C can be obtained using the next formula:

$$T_C = T_P + \sqrt{\frac{2 \cdot (3 + L + W)}{9.8 \cdot J}}$$

Where:

- T_P is the driver's reaction and perception time, measured in seconds. It is considered 2 seconds by agreement.
- L is the length, in meters, of the vehicle that crosses the main way. It is considered 10 m in order to consider a heavy vehicle.
- W is the total wide of the lanes of the preferential road, measured in metres. The wide of the AS-19 road's lanes is 7.5 m.
- J is the acceleration of the vehicle that does the crossing manoeuvre, measured in "g" units. It is considered J=0.075 for heavy vehicles.

So, the crossing time is:

$$T_C = 2 + \sqrt{\frac{2 \cdot (3 + 10 + 75)}{9.8 \cdot 0.075}} = 9.47 s$$

And the maximum speed in this stretch must be:

$$V = \frac{163 \cdot 3{,}6}{9.47} = 62 \, km/h$$

So, the maximum speed in this stretch must be limited to <u>60 km/h</u>, according with the Spanish Legislation in matter of road signing and marking. The traffic sign with the speed limit, will be placed with the "dangerous crossing" traffic sign.

7.3.3. High visibility panels

The main objective of the next proposal is to **improve the visibility of the "dangerous crossing" traffic sign**. According to the situation of this sign before the campaign, it can go unnoticed to many drivers.

In order to improve its visibility, the "dangerous crossing" traffic sign is going to be changed by a panel which will have a triangular "dangerous crossing" sign and a circular "speed limited to 60 km/h" sign. The background of the panel will be a fluorescent reflective yellow sheet.

An example of the two panels that will be placed to sign the crossing can be seen in the Illustration 19. The panel to place in the way from Avilés to Gijón warns about the danger of a crossing at the left, whereas the panel to place in the way from Gijón to Avilés warns about a dangerous crossing at the right. There is a sketch in the Illustration 24 in which it is possible to see the location of these panels.

Illustration 19: Fluorescent reflective yellow sheet panels with "dangerous crossing" and "speed limit" signs.

The fluorescent reflective yellow sheet panels add extra visibility. This is something critical to improve everybody's road safety. So, the driver is more likely to be warned about the danger, letting him adapt the speed of the car to the new situation. This is not only a benefit for the driver's safety, but also for other users of the road.

These signs have been designed according to the Spanish Legislation. The regulation used to design the panels was the "*Norma 8.1-IC, señalización vertical, de la Instrucción de Carreteras",* approved in the ORDER of 28th of December.

The reflection level of the panel is selecting using the criteria of the aforementioned "*Norma 8.1-IC*". According to this regulation, **the level of reflection of the sign will be 2 for the signs and 3 for the background**.

7.3.4. Transversal lines

The next action consists of using a system similar to the transversal warning lines. This proposal consists of several **transversal white lines**. The aim of those lines is to make the drivers feel alert, so that they know that it might be possible to do some preventive actions.

The transversal lines are placed starting at the same place than the high visibility panels with the "dangerous intersection" and the "speed limit" signs. **In this way, the driver will associate the lines with the danger due to the existence of a crossing and the obligation of a speed reduction**.

The transversal lines are designed as if they were transversal warning lines. The difference is that the former do not make either a rumble or an acoustic alert. The reason of using the quiet lines is to respect the noise legislation, because there are houses nearby that would be affected by the noise.

The distribution of these lines was established using the Spanish legislation. The regulation used was the "*Instrucción Técnica para la instalación de reductores de velocidad y bandas transversales de alerta en carreteras de la Red de Carreteras del Estado",* approved by the ORDER FOM/3053/2008.

According with the Spanish Technical Instruction, the first two lines must be separated 17 m (which is the distance that a vehicle that goes at 60 km/h travels in a second), the next line is separated 14 m (distance travelled in a second at 50 km/h), and the last 3 lines are separated 11 m (distance travelled in a second at 40 km/h). The Illustration 20 shows how these lines should be arranged. The arrangement of the transversal lines can be seen in the sketch of the Illustration 24.

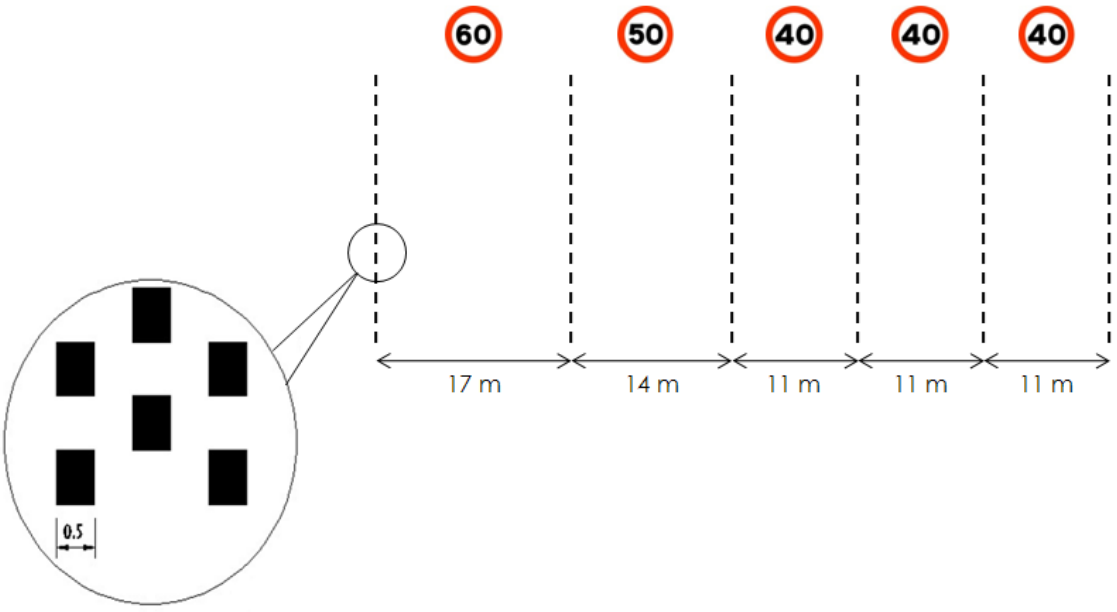


Illustration 20: Sketch with the arrangement of the transversal lines.

7.3.5. Reflecting "cat's eye" road studs (3M Marker Series 290)

Another action to carry out in this project consists of placing "cat's eye" road studs in the pavement (see Illustration 21). The aim of this action is to improve the guiding of the route and to delimit the crossing.

The **3M Marker Series 290 reflecting road studs** have been chosen for this proposal. These markers are designed to be highly effected and to increase the night visibility. This kind of road studs improve the traffic flow and provide more safety to the drivers in crossings and incorporations, as it is in this case. Furthermore, these markers intensify the road marking particularly in raining conditions.

The use of this type of road studs is very interesting, because the half of the more serious accidents registered in the lasts years were during the night (or with poor light conditions), and the half of these accidents were in raining conditions too.

Illustration 21: "Cat's eye" reflecting road stud.

A sum of **118 3M Marker Series 290 reflecting road studs** will be placed. The distribution of the road studs is: one road stud every 10 m in the areas that are far from the crossing, and every 4 m in the area of the crossing. The detailed explanation of the location of the "cat's eye" road studs is below. It is recommendable to have a look at the sketch shown in the Illustration 24 for a better understanding.

These road studs are placed in a way that the studs on the right verge in each way of the traffic are orange and the studs on the left verge in each way of traffic are white.

Distribution of the **55 road studs** at the **right verge** (in the way from Gijón to Avilés):

- Roads studs will be placed from the panel located 172 m before the crossing. The first 140 m will be **14 road studs separated by 10 m**; and the last 32 m will be **8 road studs separated by 4 m**.
- **4 road studs** will be placed in the first traffic island, **separated by 4 m**.
- **5 road studs** will be placed in the second traffic island, **separated by 4 m**.
- **9 road studs** will be placed after the crossing, **separated by 4 m**. Those will be followed by another **15 road studs, separated by 10 m**.

Distribution of the **63 road studs** at the **left verge** (in the way from Gijón to Avilés):

- **14 road studs** will be placed **separated by 10 m**, started at the same point than in the right verge.
- Other **34 road studs** will follow the previous 14, **separated by 4 m**.
- Finally, the last **15 road studs will be separated by 10 m**.

7.3.6. Linear delineation system for the crash barrier (3M LDS Series 346)

The next action consists of putting a linear **delineation system for the crash barrier**, using the **3M LDS Series 246**. An example of a LDS is shown in the Illustration 22. The aim of this action is **to warn drivers that they are in a dangerous stretch and to increase their safety by improving the delineation of the road, not only during the night, but also in broad daylight**.

This is a simple and new solution to improve in an effective way the visibility of the barrier and the delineation of the route in a dangerous stretch. The vertical undulation of these pieces maximizes the angular faces and so the visibility.

Illustration 22: Example of the linear delineation system 3M LDS Series 346 installed on a crash barrier.

A sum of **60 linear delineation system 3M LDS Series 346 will be installed** in the crash barrier. There will be **30 white-coloured 3M LDS and other 30 yellow-coloured 3M LDS**. They will be installed mixing the colours: one LDS of each colour. The size of these pieces is: 86 cm long and 15 cm high.

This delineation system will be placed in the right hand crash barrier located just after the crossing (in the way from Gijón to Avilés). There will be placed one delineation piece every 3 meters, starting 7 m after the crossing. The last LDS piece must be at the same point than the traffic panel. It is recommendable to have a look at the sketch in the Illustration 24 for a better understanding.

7.3.7. Reflecting barrier studs

This action is done in order to complement the two previous. This is used as a complement for the cat's eye studs and the linear delineation system for the crash barrier. This action proposes **to place several reflecting barrier studs in the metal barrier** in which the linear delineation system is not used.

The use of these studs is aimed at improving the visibility and the delineation of the route, especially in low visibility conditions, such as rain, fog, during the night, the dawn or at dusk.

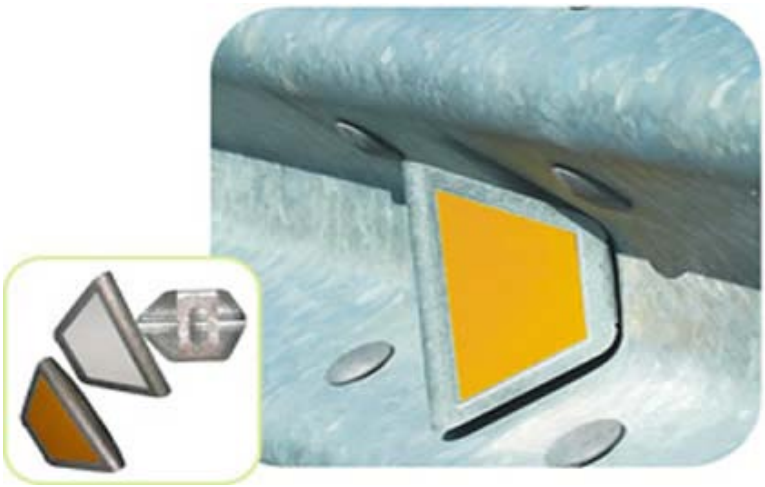


Illustration 23: Example of a reflecting barrier stud.

The kind of stud used must be **two-coloured: white and yellow**. As it happened with the "cat's eye" road studs, this kind of stud must be placed in a way that the studs on the right verge in each way of the traffic are orange and the studs on the left verge in each way of traffic are white.

The barrier studs are placed in the barrier in which the linear delineation system is not placed. It is recommendable to have a look at the sketch in the Illustration 24 for a better understanding.

A sum of **18 reflecting barrier studs** will be placed, at a distance of 10 m between one another.

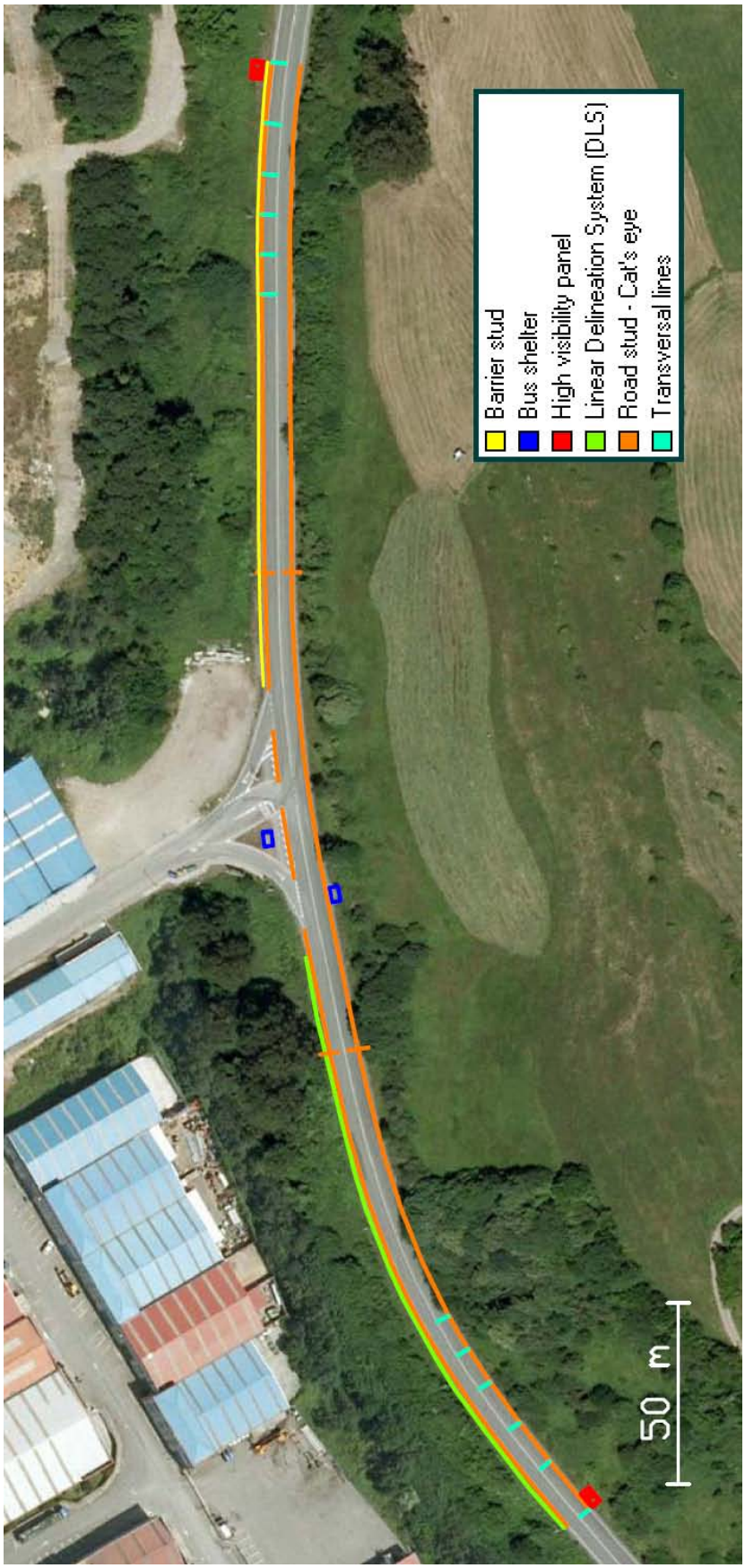


Illustration 24: Sketch with the location of the road markings, traffic signs, road studs and delineation panels.

Summary of the actions to carry out in Falmuria Industrial Park's crossing

(AS-19 Main Road, K.P. 6.0)

Actions to prepare the stretch (previous to the campaign):

- Pruning the weeds of the ditches
- Painting the road markings
- Cleaning and repairing the crash barriers
- Replacing the spoiled or broken traffic signs

Actions of the campaign:

- Calculation of the maximum speed suitable to the stretch's conditions
- Placing the high visibility panels
- Painting the transversal white lines
- Placing reflecting road studs, "cat's eye" (3M Marker Series 290)
- Placing the linear delineation system in the barrier (3M LDS Series 346)
- Placing the reflecting barrier studs

7.4. Material needed

In order to carry out the actions proposed in this project, it has been necessary the use of the material that is detailed along this section.

7.4.1. Paint

The paint used to repaint the road marking and to paint the transversal lines in the pavement needs to be white, reflective and anti-slip.

Yellow paint is also needed, in order to mark the bus stop which is located in the traffic island that is in the middle of the crossing. There have been painted several zigzag lines that delimitate the bus stop by using this yellow paint.

The paint used to paint the road markings must fulfil the Spanish legislation. The paint used in this project has been manufactured and tested according with the article 700 of the Spanish regulation "*Pliego de prescripciones técnicas generales para obras de carreteras y puentes*", approved by the Ministerial Order of 28th of December of 1999.

Furthermore, it will be used some paint for the bus shelters, that will be repainted using green and white paint.

7.4.2. Reflecting "cat's eye" road studs (3M Marker Series 290)

A sum of **118 3M Marker Series 290 reflecting road studs** will be placed, distributed along the stretch. The used road studs are two-coloured: white and yellow.

They are applied to the asphalt and offer a great effective long-life visibility, because the prismatic reflective lenses are protected by an abrasion resistant coating. These studs particularly reinforce the road marking in raining and poor visibility conditions.

These road studs have proved an optimum level of visibility during all their useful life. They are easy to clean and need a low maintenance level. This allows them to retain their initial bright and reflectivity during a long life.

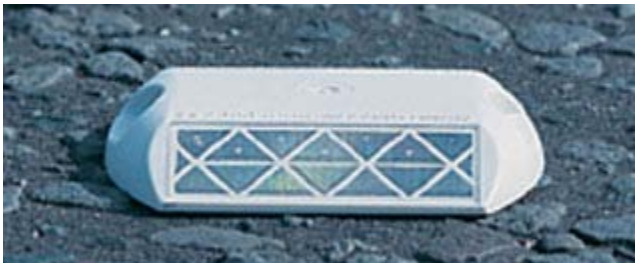


Illustration 25: Example of a 3M Series 290 reflecting road stud.

7.4.3. Linear delineation system for the crash barrier (3M LDS Series 346)

A sum of **60 linear delineation system 3M LDS Series 346 will be installed** in the crash barrier. The half of the delineation pieces will be white and the other half yellow. This is a simple and effective solution to improve the visibility of the barriers in a dangerous stretch in whatever weather condition.

The linear delineation system panels are fabricated from 3M Diamond Grade Reflective Sheeting laminated onto thin gauge aluminium. These panels are formed to a unique shape and applied to the metal barriers providing retroreflection across a wide range of entrance and observation angles.

Illustration 26: White linear delineation system 3M LDS Series 346.

7.4.4. Reflecting barrier studs

In order to complement the campaign, a sum of **18 reflecting barrier studs** will be placed in the metal barrier in which there is not any LDS piece. The same as the "cat's eye" studs, these studs must be two-coloured: white by one side and yellow by the other side.

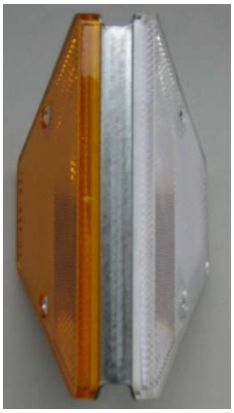


Illustration 27: Example of a two-coloured reflecting barrier stud.

7.4.5. High visibility panels

There will be made two panels. They will be used to warn drivers of a dangerous crossing where the speed limit is 60 km/h. The background of these panels will be a **fluorescent reflective yellow sheet**. This adds extra visibility to the panel, which is critical to improve the drivers' safety.

According to independent prestigious studies (*Fluorescent retroreflective signing – TNO*[1]; *Visibility of fluorescent retroreflective traffic control devices - SINTEF*[2]), the use of fluorescent traffic signs doubles the visibility of the signs during the day in comparison with the non fluorescent signs (70 % of the interviewed drivers during the studies highlighted the more visibility of the fluorescent signs, that did not go unnoticed).

The immediate consequences of placing the fluorescent traffic signs are:

- Reduction of the medium speed.
- Improvement of the alignment in the lane.
- More attention to the traffic signs.

These sheets attract the driver's attention, 24 hours a day, even more during bad weather conditions or during the dawn, dusk and night. This is thanks to its combination of the fluorescence with the highest level of reflection.

Apart from the panels that have been made particularly for this campaign, it was needed to make certain traffic signs due to maintenance reasons. This was because some traffic signs were spoiled or broken and have been replaced by new ones.

The physical phenomena of the fluorescence in the traffic signs

In the common traffic signs, the ultraviolet light, invisible to human eyes, is absorbed and not returned. This traffic signs only reflect visible light.

In the fluorescent signs, apart from the visible light, the existence of fluorescent pigments makes the ultraviolet light – which is invisible to human eyes – to be absorbed and returned to the drivers' eyes as visible light. This gives an extraordinary daytime brilliance.

[1] TNO – Human Factors Research Institute – August 1998.
[2] SINTEF – Transport Engineering – November 1995

7.5. Execution of the campaign

The establishment stage or the implementation of the campaign was divided into 6 different phases.

Phase 1: Actions to prepare the stretch.

Phase 2: Measure the speed before the campaign.

Phase 3: First set of actions of the campaign.

Phase 4: Measure the speed after the first set of actions.

Phase 5: Last action of the campaign.

Phase 6: Measure the speed after the campaign.

7.5.1. Actions to prepare the stretch

It was needed to carry out several maintenance actions before the implementation of the campaign. The preparation actions were done in order to arrange the stretch for the campaign. **The actions to prepare the stretch have been carried out between Friday 24th and Wednesday 29th.**

- The ditch of the road has been pruned in order to make the other works easy and to improve the aspect of the road. The aspect after clearing the vegetation from the ditch can be seen in the Illustration 28.

Illustration 28: Aspect of the road after clearing the vegetation from the ditch.

- The metal barriers have been cleaned and the ones that were damaged have been replaced.
- The traffic signs that were damaged have been changed and the foundations of the new traffic signs and panels have been prepared (see Illustration 29).

Illustration 29: The foundations for the new traffic signs and for the panels have been prepared.

- The road markings have been repainted.
- Both bus shelters have been cleaned and repainted (see Illustration 30).

Illustration 30: Appearance of one of the bus shelters and the road markings after being repainted.

7.5.2. Measure the speed before the campaign

After carrying out the actions to prepare the stretch, it is time to measure the speed of the vehicles that pass through the stretch. **The reason for taking the speed measures in this moment is to ensure that the campaign's results are not affected by actions that do not belong to the campaign**, such as repainting and pruning the vegetation.

The speed measures have been taken since Thursday, 30th June, to Tuesday, 5th July.

The **radar station of a driver feedback sign** has been used to take the measures. This device has the appearance of an informative panel, as it can be seen in the Illustration 31. In order to avoid the drivers' behaviour to change, the display has been switched off during the measuring time.

Illustration 31: Driver feedback sign used to measure the speed.

The driver feedback sign has been placed to measure the speed of the vehicles that where going toward the crossing in the way from Avilés to Gijón. The measured stretch is the most dangerous of the crossing: just after the curve. It is possible to see the location of the radar station in the Illustration 32 and in the Illustration 33.

Illustration 32: The radar station of the driver feedback sign measured the speed of the vehicles in the way from Avilés to Gijón.

Illustration 33: Location of the radar and detail of a dangerous situation during the bus stop.

The Illustration 33 is doubly remarkable. On the one hand it is possible to see the location of the radar station and on the other hand it is also possible to see a dangerous situation that may happen every day or almost every day. There is a bus that is doing the bus stop and a lorry is overtaking. If another vehicle being driven too fast had come, a rear-end collision would have been likely to happen.

7.5.3. First set of actions of the campaign

The campaign has been done in two sets of actions. Most of them have been done in this first set, leaving to the end the placing of the high visibility panels. **The first set of actions has taken place on Wednesday, 6th of June.**

After the first set of actions, it was left the fluorescent reflective yellow sheet panels. **The reason of separating in two sets the implantation of the campaign consisted of being able to evaluate the actions carried out before placing the sign with a new speed limit.**

Illustration 34: Dangerous crossing sign before being replaced by the panel.

The actions carried out in this first phase of the campaign have been the following ones:

- **The transversal white lines** have been painted. These lines have been placed from each of the dangerous crossing signs. The purpose of these lines is to alert the drivers in order to make them pay more attention to the action of driving.
- **The linear delineation system 3M LDS Series 346** has been installed. The linear delineation system by 3M has been installed in the crash barrier that is after the crossing in the way to Avilés. The aim of this action is to catch the drivers' attention. The linear delineation system by 3M is a new and bright device that improves the guiding of the vehicles and makes the drivers to pay more attention and reduce their speed. This type of device is effective in any situation of the weather, even in broad daylight.
- **Reflecting barrier studs** have been placed in the crash barriers. This action complements the previous one. The reflecting barrier studs are placed in the other crash barrier of the stretch. The aim is to improve the guiding of the vehicles. This system is used because it is cheaper and because it was wanted the linear delineation system to be only placed in the most dangerous zone, in order to be more effective with the drivers behaviour.

- **The reflecting road studs, "cat's eyes" (3M Marker Series 290)** have been installed. These reflecting road studs are a complement that improves the delineation of the route of the road and intensifies the other actions, especially in conditions of little light or rain. The "cat's eyes" have been placed along the whole stretch, concentrated in the area of the crossing.

Some illustrations about the condition of the crossing after the first set of actions are shown below.

Illustration 35: Delineation of the curve previous to the crossing after the actions (in the way from Avilés to Gijón).

Illustration 36: Delineation of the curve after the actions of the campaign (in the way from Gijón to Avilés).

Illustration 37: Looking towards Avilés from the crossing after the 1st set of actions.

Illustration 38: Looking to the crossing approaching on the way from Gijón to Avilés, after the 1st set of actions.

It is recommendable to have a look at section 8, in which it is shown a comparative of how this stretch was before carrying out the campaign and how it is after placing the measures proposed in this project.

7.5.4. Measure the speed after the first set of actions

After carrying out the first set of actions, the project continued with the speed measures. For it, it was used the same driver feedback sign that had been used in the measures carried out before the campaign.

In fact, this sign has been always connected and taking measures of the speed of the vehicles that passed through the crossing. It was annotated the dates and hours in which works were carried out in the stretch.

So, it is considered, that the intermediate phase of speed measurement, after the first set of actions, has been carried out **from the night of Wednesday, 6th of July to the midday of Monday, 11th of July.**

Illustration 39: Detail of the driver feedback sign placed to measure the speed of the vehicles.

7.5.5. Last action of the campaign

The ending of the campaign has consisted of placing two **fluorescent reflective high visibility panels** (one in each way). As it was said in previous sections, these panels consist of a sign to “advice of a dangerous crossing”, and a "speed limit of 60 km/h" sign.

The labour to place the fluorescent reflective high visibility panels has been carried out during the evening of **Monday, 11th of July**.

Next it is showed an illustration in which it can be seen one of the panels that have been placed after carrying out the campaign.

Illustration 40: Panel used to signpost the dangerous crossing and the 60 km/h speed limit.

It is recommendable to have a look at section 8, in which it is shown a comparative of how this stretch was before carrying out the campaign and how it is after placing the measures proposed in this project.

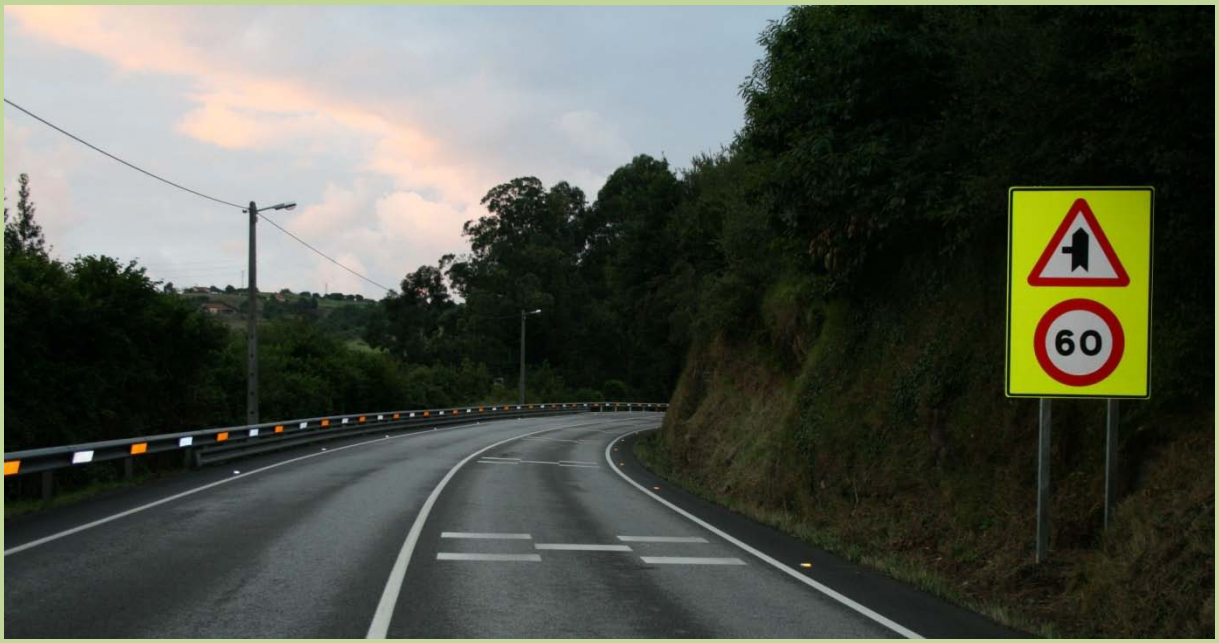
7.5.6. Measure the speed after the campaign

After the fluorescent reflective panels have been placed, it was considered that the actions of the campaign had been settled, and it was carried out the last set of measurements. These measures have been carried out **since the afternoon of Monday, 11th of July to Friday, the 15th of July**. It was initially expected to take measures until Monday, 18th of July. However, there were only taken until Friday 15th due to technical reasons.

The driver feedback sign has been still placed these days in the same place in which has been situated during the whole campaign. In this way, it was wanted that the existence of this device had as little influence as possible. That is why it has been placed in the same place and without being changed during the speed measures.

8. COMPARATIVE BEFORE & AFTER CAMPAIGN

The dangerous crossing sign was unnoticed for many drivers.



Nowadays it is rather unlikely that the drivers do not realize that the stretch in which they are driving needs more attention. The sign has been replaced with a high visibility panel. Besides, in the way from Avilés to Gijón, there are also road markings (transversal lines) and retroreflective signs (reflecting road stud and linear delineation system for the crash barrier).

Before carrying out the actions of this project, there was no speed limit in this stretch. The maximum speed was the generic for the road: 90 km/h.

After carrying out the campaign in this stretch, it has been established a new limitation of the maximum speed to 60 km/h. This limit has been calculated in agreement with the Spanish legislation relating to roads, taking into account the crossing distance and the crossing visibility.

It has been observed that the speed and the distractions were the main concurrent factors of the accidents produced in this stretch.

The actions carried out want the drivers to moderate their speed in the stretch and increase their concentration.

It is a fact that the half of the accidents took place during the night or with bad conditions of lighting.

The actions carried out made a great improvement of the safety in low visibility conditions, because they improved the delineation of the route. In addition, the reflective elements that were used are especially useful in raining conditions.

Before carrying out the campaign, the drivers meet suddenly with the intersection and the bus stops.

The drivers are now warned about the proximity to a dangerous stretch with certain anticipation. This helps the drivers to get ready to carry out additional actions, such as an emergency braking.

The most dangerous area is the exit of the curve in the way from Avilés to the crossing, due to the presence of a bus stop in an area of low visibility.

Although the actions include the whole stretch of the crossing (in both ways), they are focused to improve the safety of the vehicles that circulate in the way from Avilés to Gijón for being the most dangerous area. In this stretch the 3M linear delineation system has been placed.

In the way from Avilés to Gijón, although there is more visibility, it was still a dangerous stretch due to the high traffic flow of this crossing.

In the part of the crossing with better visibility the same actions have been carried out, with the only exception that the delineators have not been placed in the crash barriers. It is pursued that the drivers who are driving in this way moderate the speed and drive paying more attention along this stretch, because it is quite probable to come across a vehicle that is crossing the road.

The conventional sign of dangerous crossing could be unnoticed.

It is proved that the high visibility panels add extra visibility when drivers are driving with the Sun in front of them. In the way from Gijón to Avilés, the panel is complemented with road markings (transversal lines) and reflective elements (reflecting road studs and reflecting barrier studs).

9. EVALUATING THE CAMPAIGN

In this paragraph it is included a summary of the statistical study carried out in this stretch of the road. To see the complete study carried out in this project, it is recommendable to consult the annex VIII.

It has been installed a radar station to collect the data of the vehicles that drive along this stretch, in order to carry out an evaluation of the campaign. As it was said before, the device used to measure the speed has been the driver feedback sign. It has been kept with the display disconnected, in order to cause as fewer influence to the drivers' behaviour as possible.

In the Illustration 41 it can be seen how the driver feedback sign has been placed. This radar station measures the average speed in a stretch of approximately 50 meters, placed between the exit of the curve and the bus stop.

Illustration 41: Stretch in which it is measured the average speed of the vehicles.

Provided that the weather conditions are an important and influential factor in the speed of the vehicles, it has been taken into account the weather during the days that the speed was measured. The weather has been, in general, a mixture of cloudy and sunny, with slightly rains and some small summer storms. It was observed that the weather has been – more or less – the same during the three weeks. **It can be considered that the weather conditions have not had much influence in the results of this study.**

★★★★★★★★★★

The statistics have been carried out taking into account a total of 32547 vehicles.

★★★★★★★★★★

★★★★★★★★★★

Measures have been carried out in three different periods:

- **Before starting the labour** (12425 vehicles). Measures carried out after doing the maintenance works (pruning and cleaning the weeds, painting the lines, cleaning and repairing the crash barriers).
- **After the first set of actions** (9724 vehicles). Measures taken after carrying out all the actions of the campaign: installation of reflective delineation systems, reflecting road studs, reflecting barrier studs, and the transversal white lines.
- **After the campaign** (10398 vehicles). The campaign concluded with the placing of the fluorescent reflective panels.

★★★★★★★★★★

The measures have been carried out in three sets. The purpose has been to obtain enough information to be able to obtain reliable conclusions about the influence of the actions of the campaign in the speed of the vehicles along this stretch. The campaign has been separated in two blocks to evaluate: on the one hand, the placing of the delineation elements, the reflecting studs and the road markings; and on the other hand, the placing of the fluorescent reflective panels that establish a new speed limit in the crossing.

Once analyzed the data, the average values of the 85th percentile speed and the average speed have been represented in each of the three periods. Those graphics are shown in the next page and in the Illustration 48.

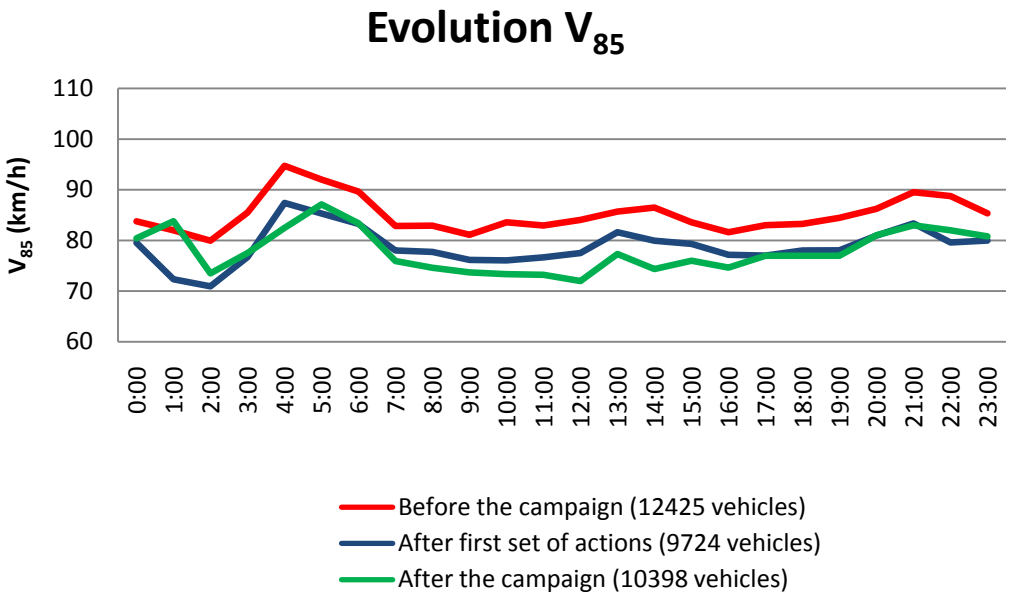


Illustration 42: Graph that shows the 85th percentile speed (V_{85}) for each period. It is possible to see that the speed of the vehicles that pass through the crossing has been reduced after carrying out the actions of the campaign.

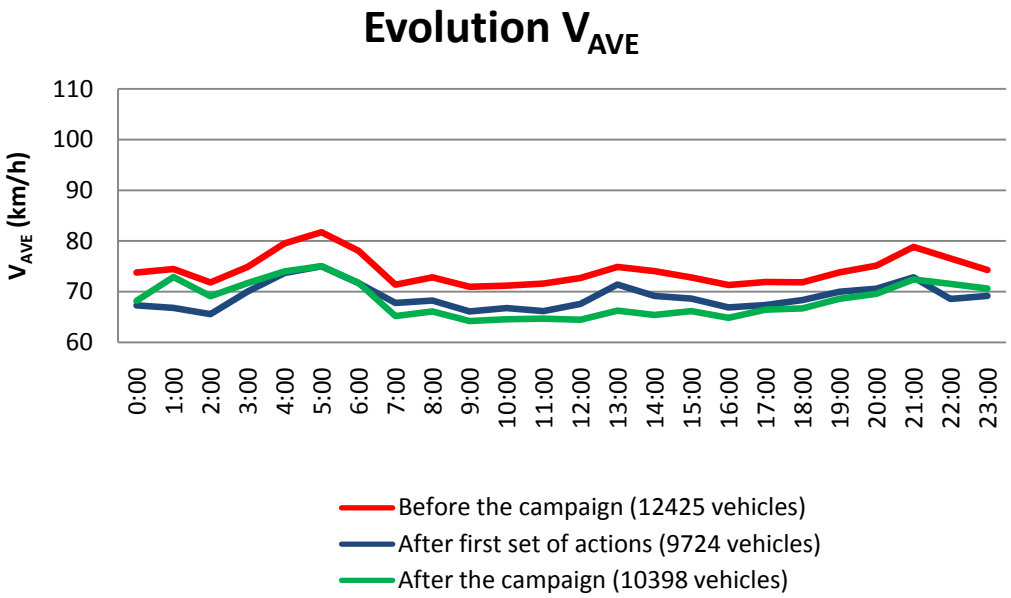


Illustration 43: Graph that shows the average (V_{AVE}) of the vehicles that have passed through the stretch during each of the considered periods. It can be seen that, after the campaign the average speed of the vehicles has also been reduced.

As it is possible to see in these graphs, the speed after the campaign has been reduced. It is interesting to quantify the exact value of this reduction of speed. For this reason, it was

calculated the percentage of reduction of the speed, in each case. These percentages are summed up in the Table 1.

Speed reduction	
After the first actions	
V_{85}	7,0%
V_{AVE}	6,8%
After placing the sign	
V_{85}	2,4%
V_{AVE}	2,4%
TOTAL with the campaign	
V_{85}	9,2%
V_{AVE}	9,1%

Table 1: Speed reduction percentage after each set of actions and the whole value after the campaign.

Taking into account the statistical speed study, it can be summed up the following numeric conclusions that have been obtained:

- *The speed of the vehicles, after the implantation of the first part of the campaign has been reduced 7 %.*
- *The speed of the vehicles, after the implantation of the second part of the campaign has been reduced 2.4 %.*
- *The speed of the vehicles, considering all the actions of the campaign together has been reduced 9.2 %.*

10. COMMUNICATION CAMPAIGN

It was wanted to let people know about this project. This project is something new and it was wanted to achieve a great repercussion. The aim has been to introduce the campaign to as many people as possible. It was used a double strategy. On the one hand, we get in touch with the most important newspaper in Asturias and, on the other hand we carried out an informative campaign through Facebook.

10.1. Impact in the media

The news has had quite a lot of relevance and has raised a lot of interest, because it has been followed by the most important journal in Asturias, called "*La Nueva España*". According to the last General Study of the Media, published for the period from November of 2010 to May of 2011, **"La Nueva España" is the most read newspaper in Asturias, with an average of 367000 readers per day**.

Since the beginning of the project, this journal has been interested in this news. In fact, they have covered the STARS Project since it was presented by Ilyas Daoud in his visit to Gijón. 1st May, 2010, they published a piece of news called "*An Erasmus in Road Safety*" (in Spanish: "*Un Erasmus en Seguridad Vial*"). The digital version of this piece of news can be read in the cutting shown in the Illustration 44.

On Sunday, 24th July, 2011, it was published in the newspaper called "*La Nueva España*" an article about this project. Under the headline "*Traffic signs that save lives*" (in Spanish: "*Señales que salvan vidas*"), there are explained the objectives of the campaign, the actions carried out and a brief description about the stakeholders. In the Illustration 45 there is the article published in the printed version of this newspaper.

The links to the digital versions of the two pieces of news about the project that have been published in "*La Nueva España*" are attached below:

- 1st of May, 2010: "An Erasmus in Road Safety" ("Un Erasmus en Seguridad Vial"):

  http://www.lne.es/gijon/2010/05/01/erasmus-seguridad-vial/908848.html

- 24th of July, 2011: "Traffic signs that save lives" ("Señales que salvan vidas"):

  http://www.lne.es/gijon/2011/07/24/senales-salvan-vidas/1106768.html

lne.es NOTICIAS Gijón lne.es noticias

Lne.es » Gijón

Un «Erasmus» en seguridad vial

El órgano europeo del transporte busca universitarios en Gijón para desarrollar iniciativas contra la siniestralidad en las carreteras

12:11 ☆☆☆☆☆

C. JIMÉNEZ

Asistentes a la presentación del proyecto «Stars» en la Politécnica de Viesques. ángel gonzález

El Consejo Europeo de Seguridad en el Transporte (ETSC) busca en Gijón universitarios de ingeniería con talento, que quieran contribuir a atajar la siniestralidad en la carretera. Sobre todo, incidiendo en medidas que apoyen una reducción de la velocidad, factor de riesgo que está presente en casi un tercio de los accidentes que se producen en las carreteras europeas. El año pasado, un estudiante de Granada tuvo una de esas buenas ideas: la duplicación de las líneas que delimitan los carriles, para que el usuario tuviera la sensación de que la carretera es más estrecha. Gracias a ello se obtuvo una sensible reducción de la velocidad en las vías donde se aplicó. «Son actividades sencillas que pueden tener un impacto grande para la seguridad vial y el tráfico», indicó en Gijón Ilyas Daoud, representante del ETSC.

Daoud presentó en la Escuela Politécnica Superior de Ingeniería, el proyecto «Stars», una iniciativa concebida para impulsar la investigación y el desarrollo de medidas innovadoras para reducir la velocidad en las carreteras de todo el territorio comunitario. Ilyas Daoud transmitió a los estudiantes de Gijón la preocupación del ETSC por la aceptación social que tiene en la mayoría de países europeos el exceso de velocidad. «Cuando vais en vuestros coches a veces se le suele quitar importancia al hecho de a circular 5 o 10 kilómetros por encima del límite», comentó. Su advertencia venía acompañada de datos: el 35% de los conductores europeos sobrepasa los límites de velocidad de las carreteras y este porcentaje aumenta hasta el 50% en vías urbanas. El resultado es que en un 80% de los accidentes el alcochol y la velocidad se convierten en una combinación de resultado letal.

Para evitarlo, la metodología «Stars» incluye un desplazamiento de los estudiantes a Bruselas donde recibirán una formación completa en materia de seguridad vial a través de conferencias impartidas por autoridades públicas. A la vuelta, trabajarán en parejas en su propio proyecto. Al finalizar este período se premiarán las tres mejores propuestas. «No es necesario plantear una idea muy ambiciosa. Se trata más bien de proyectos sencillos y de coste cero», explicó Daoud.

Illustration 44: Piece of news taken from the online edition of the journal "La Nueva España". It is related with the presentation of the STARS Project in Asturias, after Ilyas Daoud's visit to the School of Superior Industrial Engineers in Gijón. Headline: "AN ERASMUS IN ROAD SAFETY".

Domingo, 24 de julio de 2011 Gijón LA NUEVA ESPAÑA 5

MARCOS LEÓN

Alberto Martínez y Juan Luis González, de la empresa Seprinsa, junto al radar y las nuevas balizas en las vallas de seguridad.

Señales que salvan vidas

El gijonés Alberto Martínez ha sido seleccionado por el Consejo Europeo de Seguridad en el Transporte para redactar un proyecto que reduzca la siniestralidad de la AS-19

Luján PALACIOS

Reducir la velocidad, mejorar la seguridad y gastar poco. Con estas tres premisas, el gijonés Alberto Martínez ha sido seleccionado por el Consejo Europeo de Seguridad en el Transporte para desarrollar un proyecto de seguridad vial con una aplicación muy concreta: el tramo de la AS-19 entre Gijón y Avilés a la altura del polígono industrial de Falmuria.

Una zona con un tráfico «complicado, con un cruce, una curva y una parada de autobús en la que frecuentemente se producen problemas», explica Martínez, ingeniero industrial recién licenciado. Con estos ingredientes, el gijonés atendió a la llamada del organismo europeo, que buscaba en el campus a universitarios de Ingeniería con talento, dispuestos a contribuir a atajar la siniestralidad en las carreteras.

Alberto Martínez pensó en la AS-19 y su entorno industrial, y creyó que podría tratarse de un buen banco de pruebas para tratar de poner en marcha medidas sencillas que induzcan a los conductores a levantar el pie del acelerador y evitar riesgos. Tras pasar un período de formación en Bruselas y redactar un proyecto con las medidas que pensaba aplicar en este tramo, lo remitió a la Consejería de Infraestructuras, y desde ella se puso en contacto con Señalizaciones del Principado (Seprinsa) y 3M, empresas especializadas en la señalización de las vías asturianas.

MARCOS LEÓN

Las señales que se han colocado para reducir la velocidad en la AS-19.

La idea del joven licenciado, que ha trabajado en colaboración con Claudia Alonso, se resume, de manera sencilla, en la señalización con elementos luminosos y la colocación de paneles de advertencia para que los conductores sepan que se acercan a un punto conflictivo. Y, por lo tanto, que deben ser precavidos y reducir la velocidad.

Su proyecto partió, en primer lugar, de un análisis de la velocidad media de los vehículos que transitan por la zona. De hecho, se ha instalado un radar fijo «que no multa», puntualiza el ideólogo, pero sí registra a qué velocidad pasan los coches. La velocidad se ha calculado en función de la visibilidad del cruce, y fruto de estos estudios se ha bajado el límite de velocidad en este punto: «De los 90 kilómetros por hora genéricos de la vía a sólo 60», relata el ingeniero.

Fruto de su estudio, la velocidad a la altura del polígono de Falmuria ha bajado de 90 a 60 km/h

Además, se han colocado un par de paneles informativos reflectantes de alta intensidad, bandas de alerta transversales, captafaros y ojos de gato en las vallas y en el asfalto y nueva pintura. Todo ello, gracias a la colaboración de las empresas, «que pusieron el material y la mano de obra», explica. Con estas medidas de señalización, Alberto Martínez está analizando cómo influyen en la reacción de los automovilistas. El objetivo es reducir la velocidad y aumentar la seguridad, sin que ello suponga un desembolso excesivo. Y teniendo en cuenta que, aunque la seguridad es una premisa que se han marcado las administraciones públicas, «apenas hay expertos en la materia, me costó mucho encontrar quien me aconsejara y me tutelara en este proyecto».

El proyecto del gijonés ha sido elegido por el Consejo Europeo de Seguridad en el Transporte para su concurso anual, al que concurren un total de diez trabajos de seis países de la Unión Europea. En España únicamente fueron elegidos el proyecto de Alberto Martínez y otro en Valencia, y el ingeniero asturiano aspira a «ganarlo, si es posible; pienso que se trata de medidas sencillas que pueden tener su efecto».

Y, además, que pueden tener aplicación «en otros tramos calificados como puntos negros en la red de carreteras». Porque, tal y como sostiene Martínez, «lo importante al final es el conductor, que sea prudente y que no sobrepase los límites».

Las estadísticas que maneja le dan la razón: «Se puede lograr que haya un 20 por ciento menos de accidentes con sólo una reducción del 5 por ciento en la velocidad», asegura. Por eso, su proyecto podría ayudar a salvar vidas.

Illustration 45: Piece of news published on 24th of July 2011 by the journal "La Nueva España". In this article there are explained the objectives of the project, the actions carried out and there is a small explanation about the stakeholders. Headline: "TRAFFIC SIGNS THAT SAVE LIVES".

10.2. Facebook webpage

This campaign has been spread with the help of the most famous social network of the world nowadays: Facebook. The aim has been to obtain a higher media repercussion, because millions of people all over the world connect every day to this social network.

A page has been created in which it is shown information about the project and the STARS competition. Besides, it has been updated from time to time to show photographs of the actions that were carried out in the stretch.

Since its creation on 25th of June of 2011, **this page has been visited by more than 340 users and a total of 171 fans** (data taken on 28th of July). The Illustration 46 shows a screen capture of this Facebook's page. It is possible to visit this page through the following link:

http://www.facebook.com/pages/Apoya-este-Proyecto-Europeo-de-Seguridad-Vial/153603428044075

Illustration 46: Screen capture of the Facebook page created to spread this project.

This campaign has been supported by the **Official Superior Industrial Engineers Association of Asturias and León.** Across their website, they have published a release in which they announce this initiative and invite the members of the association to visit the page to obtain more information. In the Illustration 47 it is possible to see the supporting release from an institution as important as this one is.

COLEGIO OFICIAL DE INGENIEROS
SUPERIORES INDUSTRIALES
DE ASTURIAS Y LEÓN

C/. Asturias, 11 Entlo. D.
33004 OVIEDO
Tlf. 985 241 410
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coiial@coiial.es
www.coiial.es

Oviedo, 1 de julio de 2011

Asunto: Proyecto Seguridad Vial Europeo

Estimado/a compañero/a:

En relación con este Proyecto, uno de nuestros compañeros participa en una candidatura española que se presenta al Consejo Europeo de Seguridad en los Transportes.

Una de las actuaciones que se llevan cabo en la modificación de un cruce peligroso detectado tras un estudio estadístico en la carretera AS-19 (Gijón-Avilés).

Si quieres informarte de la campaña puedes acudir al siguiente enlace:

http://www.facebook.com/pages/Apoya-este-Proyecto-Europeo-de-Seguridad-Vial/153603428044075

Illustration 47: Note published by the Official Superior Industrial Engineers Association of Asturias and León, in its website to spread this project and its Facebook page.

11. CONCLUSIONS

After carrying out this project, several conclusions have been obtained.

First of all, it is possible to say that the campaign has been a success, because all the initial objectives have been achieved:

- It has been obtained a reduction of the average speed of the vehicles that pass through the stretch in which the campaign has been carried out. It has been calculated a **total speed reduction of 9.2 %.**
- **The safety of the stretch has been improved**. The installed actions have improved the delineation of the route. Besides, the attention of the drivers is higher.
- There have been used **economical and easy-to-implement measures**.

On the other hand, the campaign has been also a success because it attracted a lot of interest in Asturias:

- **The local authorities** have showed interest on this initiative and have collaborated and helped, so that that the project could have been taken to practice.
- **Private companies** have supported this initiative. **3M Spain** has contributed with part of the necessary material (reflecting "cat's eye" road studs and linear delineation system 3M LDS). Likewise, **SEPRINSA** has contributed with the labour and the rest of the material needed.
- The **main newspaper of Asturias**, *"La Nueva España"*, has also been interested in this campaign and it was published an article about this project.
- A **Facebook page** has been used to spread and show the campaign. This page has been supported by *the Official Superior Industrial Engineers Association of Asturias and León*.

12. REFERENCES

Spanish Legislation:

- Legislation from the Official State Gazette:
  - *General Traffic Royal Decree*: Real Decreto 1428/2003, de 21 de noviembre, por el que se aprueba el Reglamento General de Circulación para la aplicación y desarrollo del texto articulado de la Ley sobre tráfico, circulación de vehículos a motor y seguridad vial, aprobado por el Real Decreto Legislativo 339/1990, de 2 de marzo de 1990.
  - *Norm about road designing*: Norma 3.1-IC. Trazado, de la Instrucción de Carreteras. Aprobada en la ORDEN de 27 de Diciembre de 1999.
  - *Norm about vertical signing*: Norma 8.1-IC. Señalización vertical, de la Instrucción de Carreteras. Aprobada en la ORDEN de 28 de Diciembre de 1999.
  - *Norm about road marking*: Norma 8.2-IC. Marcas viales, de la Instrucción de Carreteras. Aprobada en la ORDEN de 16 de Julio de 1987.
  - *Article about road marking*: Artículo 700: Marcas viales, del Pliego de prescripciones técnicas generales para obras de carreteras y puentes. Aprobado en la Orden Ministerial de 28 de Diciembre de 1999
  - *Technical Instruction about transversal warning lines and speed bumpers*: Instrucción Técnica para la instalación de reductores de velocidad y bandas transversales de alerta en carreteras de la Red de Carreteras del Estado. Aprobada en la ORDEN/FOM/3053/2008 de 23 de Septiembre de 2008.

- Web page "Carretereros":
  - http://www.carreteros.org/

    This web page contains all the Spanish Legislation regarding transport, road safety, vertical signing, and road marking, and so on.

Stakeholders' web pages:

- Web of 3M España S.A.:

  http://www.3m.com/es
- Web of Señalizaciones del Principado S.A. (SEPRINSA):

  http://www.seprinsa.biz/

ANNEXES

ANNEX I: STAKEHOLDERS' SUPPORTING LETTERS

As it has been explained in the descriptive memory, this project has had the help of several stakeholders. In this annex there are gathered the letters of each of the private companies and official organizations that have supported this project.

Given that the recommendation letters are written in Spanish, in this annex there will be a short summary of each letter, before the copy of the original letters. The stakeholders' supporting letters are:

- Dirección General de Carreteras, Transportes y Asuntos Marítimos

The "Dirección General de Carreteras, Transportes y Asuntos Marítimos", responsible of the actions in matter of roads in Asturias, shows its support to this initiative that aims to carry out economical measures that may help to reduce the excessive and inadequate speed.

Mr. César Orejas Fernández (Maintenance Service Manager) and Mr. Carlos Rayón Martín (Road Safety Manager) have signed this letter, representing the local authorities. They have contributed with this project giving continuous advice, making the maintenance labours in the stretch and placing a radar station to measure the speed.

- Señalizaciones del Principado S.A. (SEPRINSA)

The Asturian Company SEPRINSA has worked in the road signing sector for years. Nowadays it is one of the strongest companies of the sector. For this reason, the European competition STARS has been of their interest and that is why they have decided to sponsor this project. They have provided almost all the labour needed, and they have paid for and made part of the material needed to implement the campaign. Mr. José Luís González Rodríguez, SEPRINSA's Technical Director, signs this supporting letter.

- 3M España, S.A.

The company 3M Spain S.A. is an American Multinational distinguished by a constant commitment in doing safety roads, being a leader in the investigation of reflective sheets and technologies. In this letter signed by Mr. Luis Estremera (Sales and Marketing Manager of the Road Safety Department), the company 3M shows his support to this initiative that looks for reducing the speed in a stretch and managing to improve the conditions of visibility and safety of the stretch chosen for the project. For this reason, 3M has contributed with reflective road studs 3M Marker Series 290 and linear delineation system 3M LDS Series 346.

- European Transport Safety Council (ETSC)

Mr. Antonio Avenoso, Executive Director of the European Transport Safety Council, has not hesitated to write a letter to support this project. In this letter he presents this project and the STARS competition that consists of the identification of a stretch of road in which it can be established innovative and economic measures that allow to reduce the excessive speed and the number, frequency and gravity of the traffic accidents. He explains that this candidature is taking part together with other 10 candidatures of 6 European countries.

Dirección General de Carreteras, Transportes y Asuntos Marítimos

La *Dirección General de Carreteras, Transportes y Asuntos Marítimos* dirige y coordina las acciones en materia de carreteras de titularidad del Principado de Asturias, en cuanto al proceso de planificación, redacción de documentos de evaluación y proyectos, construcción, conservación, explotación y policía administrativa de las mismas, así como en el apoyo técnico a todas las obras de la Consejería, u otros órganos de la Administración que lo precisen, en materia de geología, materiales y calidad en la construcción. Asimismo, dirige y coordina el ejercicio de las funciones de la Consejería en materia de transportes por cualquier modo, incluyendo la planificación, redacción de documentos de evaluación y proyectos, construcción, conservación, explotación y policía administrativa de las infraestructuras portuarias y de transporte de su competencia. Del mismo modo, le corresponde el impulso de aquellos instrumentos de coordinación con otras entidades públicas o privadas que contribuyan a su mejora, especialmente en las políticas de coordinación intermodal de los transportes y la promoción de los entes creados para consecución de dichos objetivos.

Desde la *Dirección General de Carreteras, Transportes y Asuntos Marítimos* queremos mostrar nuestro apoyo a esta iniciativa de mejora de la Seguridad Vial llevada a cabo por *Alberto Martínez Rodríguez* y *Claudia Alonso Carrión,* con motivo de su participación en el *Concurso Europeo de Seguridad Vial STARS*, organizado por el *Consejo Europeo para la Seguridad de los Transportes (ETSC)*, y que trata poner en práctica medidas poco costosas que permitan reducir la velocidad excesiva e inadecuada.

El proyecto planteado por *Alberto* y *Claudia* trata de mejorar la seguridad en un tramo de la carretera AS-19, concretamente en la intersección situada en el P.K. 6,0. Su iniciativa trata de reducir la velocidad en este tramo mediante actuaciones de bajo coste conforme a la normativa vigente en materia de carreteras.

La iniciativa nos ha parecido de interés, dado que además se podría enmarcar dentro de las estrategias desarrolladas por nuestro programa de Seguridad Vial. Por este motivo, la *Dirección General de Carreteras, Transportes y Asuntos Marítimos* ha apoyado y contribuido con este proyecto de la siguiente forma:

- Realizando asesoramiento técnico y legal sobre la normativa vigente en nuestro país en materia de carreteras.
- Colaborando con nuestra propia experiencia para orientar sobre qué medidas pueden resultar mejores de entre las propuestas por *Alberto* y *Claudia*.
- Facilitando los contactos necesarios para dar a conocer personas y empresas que pudiesen estar interesadas en participar en este proyecto.
- Realizando trabajos de desbroce para acondicionar el tramo como parte de la conservación ordinaria.
- Instalando una estación de toma de medidas de velocidades del tramo.

En Oviedo, a 1 de Julio de 2011,

D. César Orejas Fernández
Jefe del Servicio de Conservación

D. Carlos Rayón Martín
Jefe de Sección de Seguridad Vial

SEPRINSA
SEÑALIZACIONES DEL PRINCIPADO S.A.
C/ Peña Salón, Parcela 56-A
Polígono de Silvota - 33192 Llanera (Asturias)
Tlf.:985 26 62 42/ 985 26 76 45 / Fax: 985 26 51 85
Web: www.seprinsa.com

Señalizaciones del Principado, S.A., *conocida comercialmente como (SEPRINSA),* es una empresa asturiana que desde 1986 (año en el que se fundó) hasta el día de hoy se ha dedicado a la señalización vial, creciendo con pasos firmes, hasta convertirse en la actualidad en una de las entidades más consolidadas e innovadoras dentro del sector empresarial al cual pertenece.

Gracias a la capacidad de esfuerzo y mantenimiento de su mejor capital; un equipo de 60 profesionales que aportan experiencia, recursos y capacidades organizativas a la empresa, **SEPRINSA** se ha posicionado como compañía líder tanto al servicio de entidades privadas como administraciones públicas. Para satisfacer las expectativas de sus clientes ha implantado un sistema de gestión que cumple con los requisitos aplicables a la norma de aseguramiento de calidad ISO 9001:2008. a la norma de gestión medioambiental ISO 14001:2004 y a la norma OHSAS 18001:2007 gestión de la salud y seguridad laboral.

SEPRINSA está ubicada en el centro de Asturias donde cuenta con unas modernas instalaciones así como una completa flota de vehículos y maquinaria.

El Objeto Social de esta sociedad está orientado a la Mejora de la Seguridad Vial; esto abarca: aplicación de pinturas especiales para *señalización horizontal*, instalación de todo tipo de barreras de seguridad (barreras metálicas, mixtas y protección de motos), señalización vertical (carteles luminosos, pórticos y banderolas), mallas de protección de taludes, como cualquier otra actividad relacionada directa ó indirectamente con la señalización y *balizamiento* de carreteras, calles, aeropuertos, aparcamientos. Destacando también una sección especial a la colocación de cerramientos tanto metálicos de todo tipo como de hormigón y derivados.

SEPRINSA, desarrolló su actividad en la comunidad asturiana en sus comienzos pero en los últimos años opera en todo el territorio nacional, aunque el volumen de su facturación se debe a obras realizadas principalmente en las provincias de las comunidades de Principado de Asturias, Cantabria y Castilla-León.

El concurso Europeo de Seguridad Vial "STARS", organizado por el Consejo Europeo para la Seguridad de los Transportes (ETSC), ha sido de gran interés para **SEPRINSA**. Por este motivo, nada más conocer la propuesta planteada por Alberto Martínez Rodríguez y Claudia Alonso Carrión, para mejorar la seguridad en un tramo de la carretera AS-19, ha decidido involucrarse en el mencionado proyecto, participando activamente.

La forma de sponsorizar este proyecto, consiste en la aportación, por parte de **SEPRINSA**, de prácticamente la totalidad de la mano de obra necesaria para implementar la campaña. Además, comprará o fabricará parte del material necesario. A continuación se enumera un listado de las actividades que dicha empresa desarrollará dentro del marco de colaboración con este proyecto.

- Limpieza y reparación de las barreras metálicas.
- Pintado de las marcas horizontales.
- Colocación de los captafaros de pavimento.
- Colocación de los captafaros de barrera metálica.
- Fabricación y colocación de las nuevas señales y reposición de las existentes en mal estado.
- Fabricación de las pletinas necesarias para anclar los captafaros a la barrera metálica.

En Llanera, a 20 de Julio de 2011

D. JOSE LUIS GONZALEZ RODRIGUEZ

DIRECTOR TECNICO

Estimado Sr./Srs,

Escribo esta carta con el ánimo de apoyar el proyecto Europeo de seguridad vial que están llevando a cabo Alberto Martínez Rodríguez (Licenciado en Ingeniería Industrial) y Claudia Alonso Carrión (Diplomada en Turismo).

La empresa 3M es una multinacional estadounidense fundada en el año 1902 y dedicada a investigar, desarrollar, manufacturar y comercializar diversas tecnologías, ofreciendo productos y servicios innovadores a nuestros clientes en diversas áreas. Una de estas áreas es la de la seguridad vial. El compromiso de 3M de hacer una carretera más segura ha dado como resultado el constante desarrollo de nuevos productos , tecnologías y sistemas, por eso, durante más de 60 años, 3M ha estado a la cabeza de la investigación en láminas y tecnologías retrorreflectantes. Además, en 3M tenemos un compromiso de calidad con nuestros productos. Utilizamos la fabricación y los equipos de control más avanzados para asegurar la idoneidad de todos los productos.

Alberto y Claudia, a través del proyecto STARS, buscan reducir la velocidad y aumentar la seguridad en una intersección especialmente peligrosa de la carretera AS-19. Esta intersección se caracteriza por el tráfico denso y una baja visibilidad. Esta iniciativa ha parecido muy interesante a nuestra empresa y, por este motivo, nos hemos comprometido a participar en ella, aportando el material necesario para llevarla a cabo. Para ello, 3M suministrará láminas retrorreflectantes Clase 3 Diamond Grade para las correspondientes señales de tráfico, captafaros para el pavimento Serie 290 y captafaros LDS para su colocación en la barrera metálica.

Sin otro particular, les saluda atentamente,

D. Luis Estremera
Departamento de Sistemas de Seguridad Vial
Jefe de Ventas y Marketing

Bruselas, 6 de Junio 2010

Estimado Sr/Sres.

Me dirijo a usted/es para apoyar la propuesta y el proyecto de seguridad vial co-dirigido por Alberto Martínez Rodríguez y Claudia Alonso Carrión, ambos estudiantes de la Universidad de Oviedo.

Los dos forman parte de los 22 estudiantes de ingeniería y comunicación seleccionados en 6 países europeos, compitiendo en el proyecto STARS (Students Acting to Reduce Speed). STARS es un proyecto de 12 meses dirigido por la ETSC (Consejo Europeo para la Seguridad de los Transportes) que tiene por objeto movilizar la investigación sobre la gestión de la velocidad y demostrar que la velocidad excesiva e inadecuada en las carreteras se puede reducir mediante acciones innovadoras y/o poco costosas. El diseño de carreteras más seguras a través de la gestión de la velocidad, especialmente en los sitios de riesgo, reduce de forma efectiva y sostenible el número, frecuencia y gravedad de los accidentes de tráfico.

El proyecto STARS se centra en la gestión de la velocidad a través de acciones específicas en infraestructura y comunicaciones, dirigidas por futuros ingenieros y expertos en comunicación. La gestión de la velocidad es un campo de la seguridad vial, donde la reducción de accidentes es lo más importante, sostenible y viable y con un coste relativamente asequible.

Los estudiantes que participan en STARS fueron seleccionados entre muchos candidatos, por su motivación, su compromiso, sus ideas y las medidas que presentaron. Ellos siguieron un seminario completo en Bruselas sobre la velocidad en el tráfico y la seguridad vial por muchos expertos, asociaciones, instituciones europeas y empresas que trabajan en estos temas.

Alberto y Claudia identificaron el tramo de la carretera AS-19 como un sitio de especial relevancia para el tratamiento y apoyo a las ideas y las medidas que desean presentar. Con base a sus resultados, los mejores estudiantes de cada país serán invitados a Bruselas para participar en una entrega de premios y presentar los resultados de sus esfuerzos a científicos, responsables políticos y empresas privadas. Estos eventos ofrecen excelentes oportunidades para promocionar las mejores prácticas y experiencias en las campañas de seguridad vial basadas en conocimientos científicos en Europa.

Le doy las gracias de antemano por la atención y el tiempo que dedicará a este proyecto y su aplicación.

Atentamente,

Mr. Antonio Avenoso
Director ejecutivo de la ETSC

ANNEX II: CHOOSING THE LOCATION FOR THE CAMPAIGN

1. Choosing the road

To choose the appropriate place to carry out the project, it has been done a statistical study of 215 Km from different stretches of Asturian roads located around the city of Gijón.

The studied roads and distances have been the following ones:

- AS-19: 22 Km
- AS-17: 102 Km
- AS-110: 11 Km
- AS-118: 11 Km
- AS-116: 10 Km
- N-632: 59 Km
- **TOTAL: 215 km**

The data of this study has been obtained from the National Observatory of Road Safety. They represent the accidents with victims produced in the mentioned roads from 1st of January 2000 to 31st of December 2009.

The first criterion to select the appropriate place to locate the campaign has been the number of mortal accidents. Those roads in which there was not any mortal accident in the last decade have been rejected in this phase of selection. The Table 2 shows the mortal accidents produced in each of the roads.

Number of mortal accidents per road	
Road	**Nº of mortal accidents**
AS-19	18
AS-17	42
AS-110	0
AS-118	2
AS-116	0
N-632	0

Table 2: Number of mortal accidents per road.

In this way there were rejected from the study three of the roads involved that did not have any mortal accident (AS-110, AS-116 and N-632). To select a road between the 3 left, it was used a second criterion of selection. This one consisted of selecting the road with more density of accidents with victim per kilometre of road. In the Table 3 the number of accidents with victims of each studied road is gathered with the density of accidents per kilometre.

Density of accidents with victims per kilometre and road			
Road	**Nº accidents with victims**	**Studied kilometres**	**Density (accidents / km)**
AS-19	352	22	**16,0**
AS-17	1066	102	**10,5**
AS-118	27	11	**2,5**

Table 3: Density of accidents with victims per kilometre and road.

After having a look to the results of density of accidents per kilometre of road, it was decided to choose the road **AS-19**. This road joins the cities of Gijón and Avilés. The later study and the campaign will be carried out in this road.

2. Finding the most dangerous stretch

Once it was decided to do the study and the campaign in the AS-19 main road, it was needed to continue analyzing the statistics of this road to detect a possible concrete stretch that was appropriated to implant the campaign in.

The study showed in this paragraph, has been used to do the first approximation. In this study, it is located the stretch of the road where there is a concentration of the most serious accidents.

However, for the choice of the place to carry out the campaign, there were used, apart from this study, the information obtained of the field investigations and the conversations maintained with road safety experts.

The study carried out to detect the most dangerous stretch of the AS-19 Main Road is showed next.

There have taken place a total of 352 accidents with victims between 1st January 2000 and 31st December 2009 in the AS-19 Main Road. The Table 4 shows a balance sheet of 553 victims that have been in these 352 accidents.

Victims Balance	
Mortal victims	21
Seriously injured victims	96
Slightly injured victims	436
TOTAL	**553**

Table 4: Victims of accidents balance.

First, all the accidents with mortal victims between 2000 and 2009 have been analyzed. The Table 5 shows a summary of all the accidents with mortal victims. As it can be seen, many of them are in a specific stretch of the road, between the K.P. 9.1 and the K.P. 11.4. In the Table 5 it can be seen in shady colour the accidents that have happened in this stretch.

The table shows that in the road AS-19 there is a stretch of 2.3 km in which there is a concentration of serious accidents. In the field investigations done to the road, it was seen that this stretch is an area of big straights with continuous brows of hills, in which the drivers use to drive at high speed.

Date	K.P.	No. victims	Speed
2000-01-14	19,7	1	NO
2001-02-19	6,5	1	NO
2001-03-27	9,2	1	NO
2001-11-28	9,6	1	NO
2002-02-11	17,8	1	NO
2002-05-01	9,1	1	SI
2002-08-14	14,4	1	NO
2002-11-22	9,1	1	NO
2003-05-04	17,7	1	SI
2003-08-16	11,4	4	SI
2004-02-03	11,4	1	NO
2004-11-25	4	1	NO
2005-09-06	9,2	1	SI
2005-10-13	14,5	1	SI
2006-06-24	11	1	NO
2006-07-22	7,5	1	NO
2007-03-22	7	1	NO
2007-07-26	10	1	NO

Table 5: Number of mortal accidents.

As it is shown in the Table 5, 8 out of the 18 mortal accidents happened in a short stretch of 2.3 Km on a road of 22 km. It means that, in a 10 % of the road there happened almost the half of the mortal accidents of the whole road (a graphic can be seen in the Illustration 48).

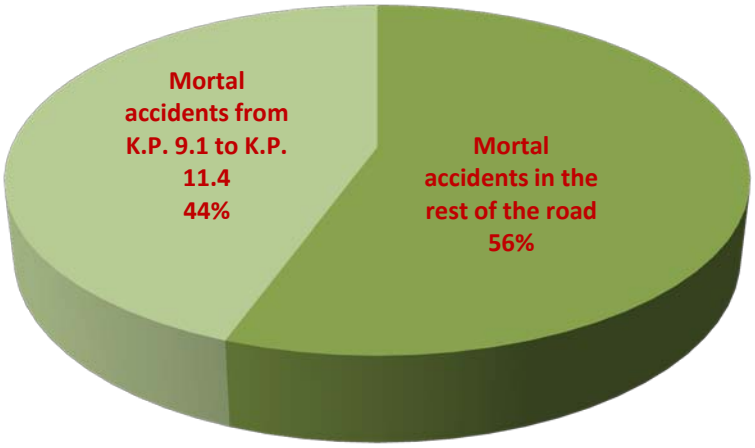


Illustration 48: Percentage of mortal accidents that take place between the K.P. 9.1 and the K.P. 11.4, and accidents that take place in the rest of the AS-19 main road.

This stretch is a place to which it is important to pay attention because the accidents that take place are especially serious. Provided that it is in an area of straights, it is proceeded to verify if it is possible to say that the speed is a relevant aspect in the accidents that take place in this stretch.

In all the studied stretch of road, 22Km, 352 accidents with victims have been registered in these last ten years, inside which, the speed has been the concurrent factor in 57 of them. It supposes that the speed has been involved at least in 16 % of the accidents happened in this road (seeing the Illustration 49).

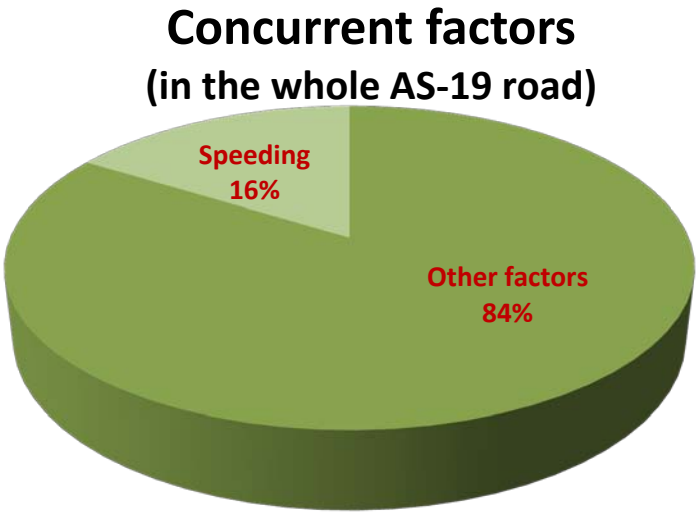


Illustration 49: Speeding is a concurrent factor in 16 % of the accidents of the AS-19 main road.

If the study is exclusively focused on the stretch that goes from the K.P. 9.1 to the K.P. 11.4, it is obtained that, out of 28 accidents with victims happened in this stretch, in a 32 % of them speeding has been a concurrent factor (it can be seen the graph in the Illustration 50). It can be said that, in this stretch the number of accidents that take place due to speeding is the double than the average for the whole road.

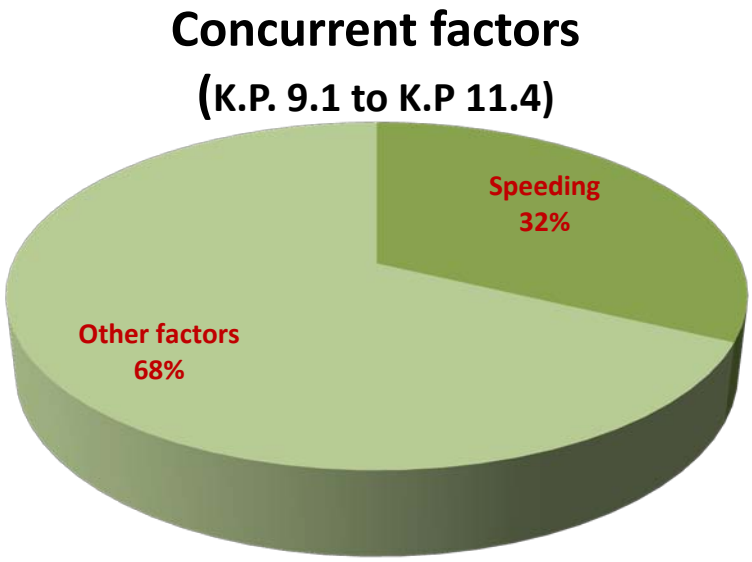


Illustration 50: In the stretch between the K.P. 9.1 and the K.P. 11.4, the speed is a concurrent factor in 32 % of the accidents.

In spite of the fact that in this paragraph it has been detected a stretch in which the percentage of fatal accidents is higher than in the rest of the road, the campaign has been done in another stretch. The study has been used to help before the field investigations. However, after visiting the road, **there were detected four suitable stretches in which it might be possible to implant the campaign**.

The reasons because each of the proposals have been rejected are in the annexes IV, V and VI. The criterions of choice have been the following ones:

- Meetings with Road Safety experts.
- Viability of the project.
- Suitable characteristics and philosophy of the STARS project.

With all these considerations it has been decided to locate the campaign in the area of the crossing in the K.P. 6.0, which gives entry to the Falmuria Industrial Park. The reasons by which this stretch has been chosen are detailed in the section 6 of the Descriptive Memory, which is about “Choosing the localization”.

3. Characteristics of the AS-19 main road

This road has the highest density of accidents per kilometre due to some special characteristics.

These are some of the most highlighting characteristics of this road:

- The AS-19 main road is – between the studied ones – the one with highest density of accidents per kilometre.
- In 2.3 Km out of the 22 km of the road, there concentrates 44 % of the mortal accidents happened.
- In this stretch of 2.3 km, 32 % of the accidents are due to speeding.
- It is a road with a lot of traffic flow, due to the great number of surrounding industries. This produces heavy traffic in rush hours and a high amount of heavy vehicles that hold up the traffic. In 2010, the ADT has been of 20801 in the stretch with the highest density of traffic. In addition, the percentage of heavy vehicles overcomes 14 %.
- There is a high number of nearby industries.
- There are many cyclists that train in this road.
- There is a great amount of crossings, entries and exits for private ownerships and little towns.
- There are long straights with brow of hills and opened curves at the end of the straights.

All these facts make the AS-19 Main Road – and especially some stretches – to possess those so negative statistics regarding accidents and victims.

ANNEX III: MAP OF THE AS-19 MAIN ROAD

The itinerary of the **AS-19** Main Road in ascending way of the distance in kilometres, passes through the following cities: Gijón, El Empalme, Prendes, Tabaza y Avilés.

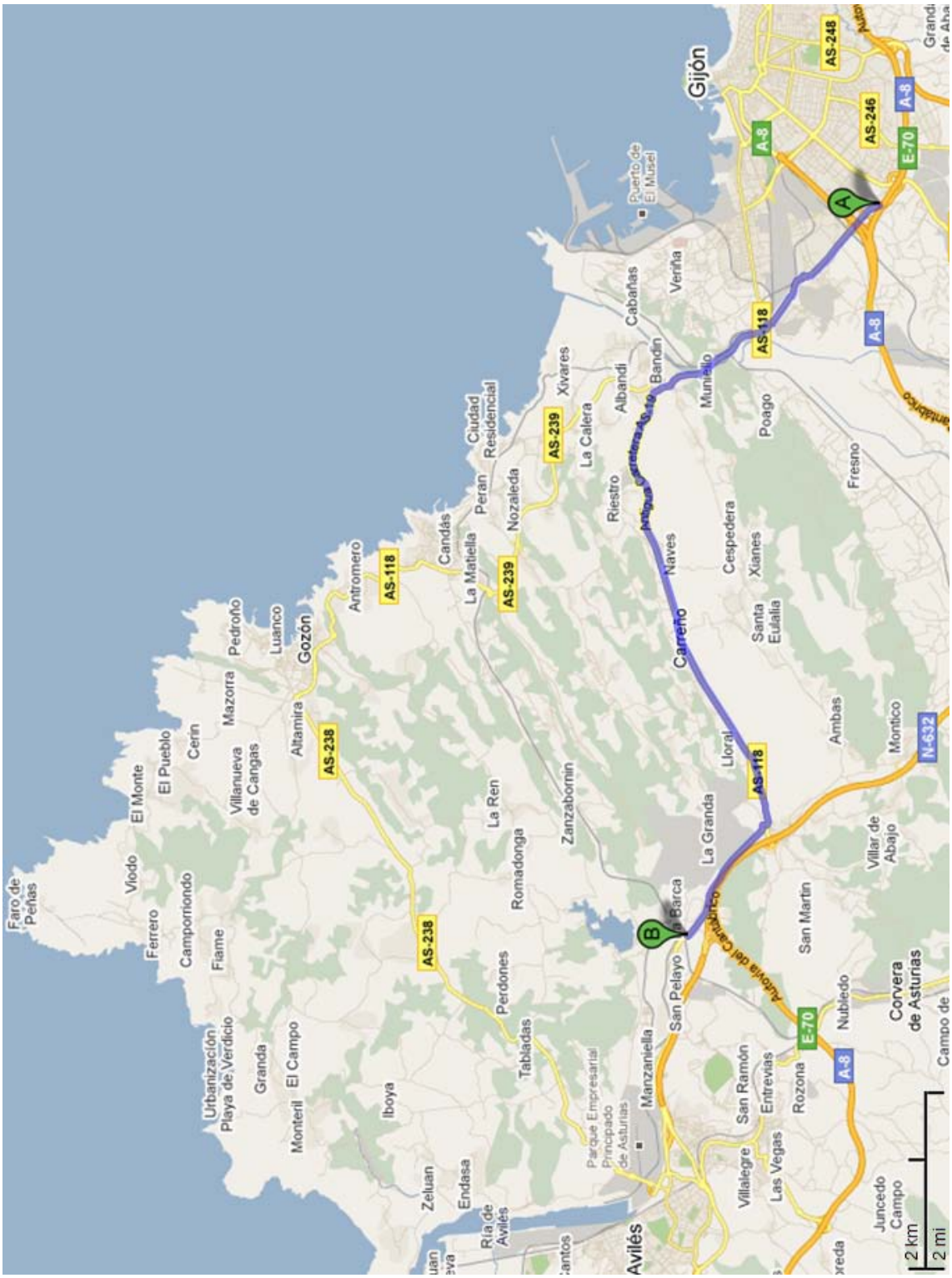


Illustration 51: Map of the AS-19 Main Road.

ANNEX IV: PROPOSAL IN A STRETCH WITH A HIGH PERCENTAGE OF MORTAL VICTIMS

1. Location

To carry out this project, first a campaign was raised in the stretch of the AS-19 Main Road corresponding to the **interval that goes from the K.P. 9.0 to the K.P. 11.5.**

The reason of carrying out the campaign in this stretch would be explained itself with the statistics showed in the Annex II. In that annex it has been seen that it exists a stretch between K.P. 9.1 and K.P. 11.4 that has especially serious statistics and some characteristics that aggravate more the dangerous of the stretch. Some of them can be summed up by the following way:

- This stretch concentrates 44% of the mortal accidents happened in the whole road.
- In this stretch, there happen 17% of the accidents occurred due to speeding in the whole road.
- 32 % of the accidents produced in this stretch are due to speeding.

These statistics and the characteristics that the route has, made that this stretch could have been a suitable place for the location of the project. This first place that was proposed for the emplacement of the campaign could have been defined as a "very serious accident concentration stretch, mostly due to speeding".

2. Current situation

Certain road stretches are known for having a number of accidents higher than the average. These stretches are in occasions signposted as Stretch of Accident Concentration (at least in Spain). The Illustration 52 shows an example of the typical signs used to signpost the beginning and the end of a stretch of accident concentration.

These stretches have, in many occasions, several kilometres. The initial sign warns the driver of a higher probability of accident. However, it can happen that the driver does not see this sign of warning, or that, after several hundred meters he forgets that he is still driving inside a stretch of accident concentration.

Illustration 52: Signs which are used to signpost the beginning and the end of a stretch of accident concentration.

Nowadays, the stretch in which it was proposed to carry out this campaign has not any "*stretch of accident concentration's*" signs, or any other kind of signposting that indicates to the drivers that they are driving along a stretch of special danger.

After consulting Road Safety experts of the "Dirección General de Carreteras y Asuntos Marítimos", it was confirmed that this stretch of road, almost every year appears as a stretch of accident concentration. The signposting of Stretch of Accident Concentration was put on according to the stretch of accident concentration that had appeared the previous year to the placing of the sign. It was just a coincidence that this stretch had not been a stretch of accident concentration the previous year to the placing of the signs in this road. For this reason it is not signposted as a stretch of accident concentration.

3. Proposal

It was proposed a campaign which purpose would be to announce the drivers that they were driving along a Stretch of Accident Concentration of special dangerous. It has been tried to look for a simple solution that could have the highest possible repercussion. The intention was to propose a very economic and viable solution, which could be taken to practice easily.

The idea was based on placing a traffic sign at the beginning of the stretch and painting a continuous red line in the verge.

First, the sign would warn the dangerous of the stretch with a message that it should affect the driver. This sign would take a design as the one that appears in the Illustration 53.

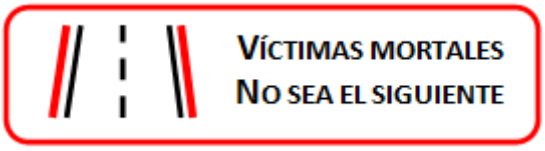


Illustration 53: Example of how the sign would be. It reads: "Death Victims, Do not be the next one".

With this sign, it was wanted to obtain a double objective. On the one hand, it was expected to attract the attention of the drivers and to inform them about the dangerous of the stretch along they were driving, and on the other hand, it was wanted to inform the drivers that the red line that they would see in the verge of the road meant that they are still driving along a dangerous stretch.

Secondly, a continuous line would be painted with reflective red paint in each of the verges (Illustration 54). These lines would paint for the exterior side of the route in order not to reduce the width of the traffic lane.

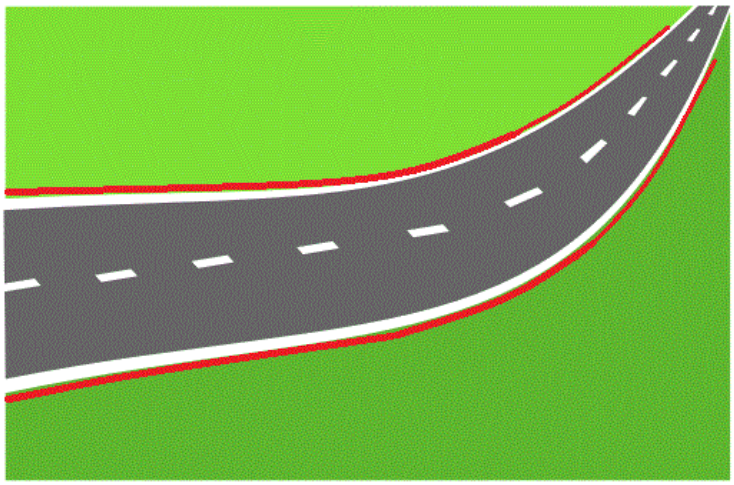


Illustration 54: Representation of how the red lines would be painted in the stretch

With these red lines, a double objective was looked for again. On the one hand, with these lines the driver would see that the stretch is really dangerous. On the other hand it would avoid that the situation of being driving along a dangerous stretch was unnoticed (or forgotten) by the driver.

4. Reason to reject this location

This proposal has been rejected after several meetings with experts of the "Dirección General de Carreteras, Transportes y Asuntos Marítimos". The reason was that it might not be interpreted properly by all the drivers.

The fact that **neither the sign, nor the road markings in the pavement are regulated according to the Spanish Highway Code**, does that this action is risky. There is not any norm established that regulates this proposal because it is completely new. This **could be a reason of distraction for the drivers**, because they might pay more attention to fix and understand the new sign and the new traffic marks, rather than driving with more precaution along this stretch. The consequence of this would be the opposite one to the searched with the implantation of these actions. It would be possible that the number of accidents increased due to the distraction of the drivers, instead of being reduced due to the impact of the new signposting. **For this reason and providing the great importance of the AS-19 Main Road, experts of the "Dirección General de Carreteras, Transportes y Asuntos Marítimos", advised to reject this action and they propose looking for other actions that upheld with the Spanish Legislation about roads.**

Another aspect that has been important at the moment of rejecting this location has been the topic of the legal coverage. If these actions did not have the awaited effect and failed, there would not be a legal explanation to justify the implantation of these actions, because neither the sign nor the road markings are regulated by the Spanish Legislation.

ANNEX V: PROPOSAL IN THE CROSSING BETWEEN TWO STRAIGHTS

1. Location

This crossing is located between two long straights in the **K.P. 9.4 of the AS-19 Main Road**. Providing that it is an opened curve that joins two big straights, drivers usually pass through this stretch in a speed higher than the allowed in this point. These facts have a clear repercussion statistically. In the last 9 years there have been 5 mortal victims in two very serious accidents in this crossing. In the most serious accident, in which 4 mortal victims have taken place, it looks as if speeding had been the principal concurrent factor. These data were determinant at the moment of taking the decision to carry out some actions that were focused to reducing the speed of the vehicles to its step along this crossing.

Besides, it is necessary to highlight that this point is doubly dangerous because it not only consists of a opened curve between two straights, but also **in the middle of the curve there is a crossing that gives access to several villages.** In the Illustration 55, it can be seen a satellite photography of the location of this point.

Illustration 55: Satellite sight of the crossing located in the curve in the stretch of straights (K.P. 9.4).

2. Current situation

Nowadays, this crossing is located in a stretch of straights that presents the following characteristics:

- Drivers who join to the AS-19 Main Road from this crossing have very little visibility of the vehicles that circulate on the way from Avilés to Gijón. In the Illustration 56 it is possible to appreciate the low visibility that there is in the crossing on the way from Avilés. In this way, it is possible to have the case of which a vehicle joins to the AS-19 Main Road just in the moment in which another vehicle comes to this point with high speed. There is a considerable risk of rear-ended collision.

Illustration 56: View from the crossing, on the way from Avilés, visibility is too small.

- It has been observed that there is a sign indicating the existence of a crossing in one side of the road (in the left side on the way from Gijón to Avilés and in the right one in the opposite direction), as it can be seen in the Illustration 57. In fact, just after the sign there is not only an exit for this side, but there is also another on the other side. This has as consequence that the drivers do not pay attention to the possible exit of a vehicle from both sides of the road, increasing the risk of accident.

Illustration 57: Signposting of the existence of the crossing in the curve.

- On the way to Gijón, as it can be seen in the Illustration 58, there exists a sign that allows overtaking just before the curve. This does that the condition of low visibility of the crossing is more highlighted, because the vehicles that are driving from Avilés, can do it with a maximum speed of 110 km/h if they are doing an overtaking manoeuvre, allowed in this point.

Illustration 58: Sight of the curve on the way from Gijón. The visibility of the crossing is low.

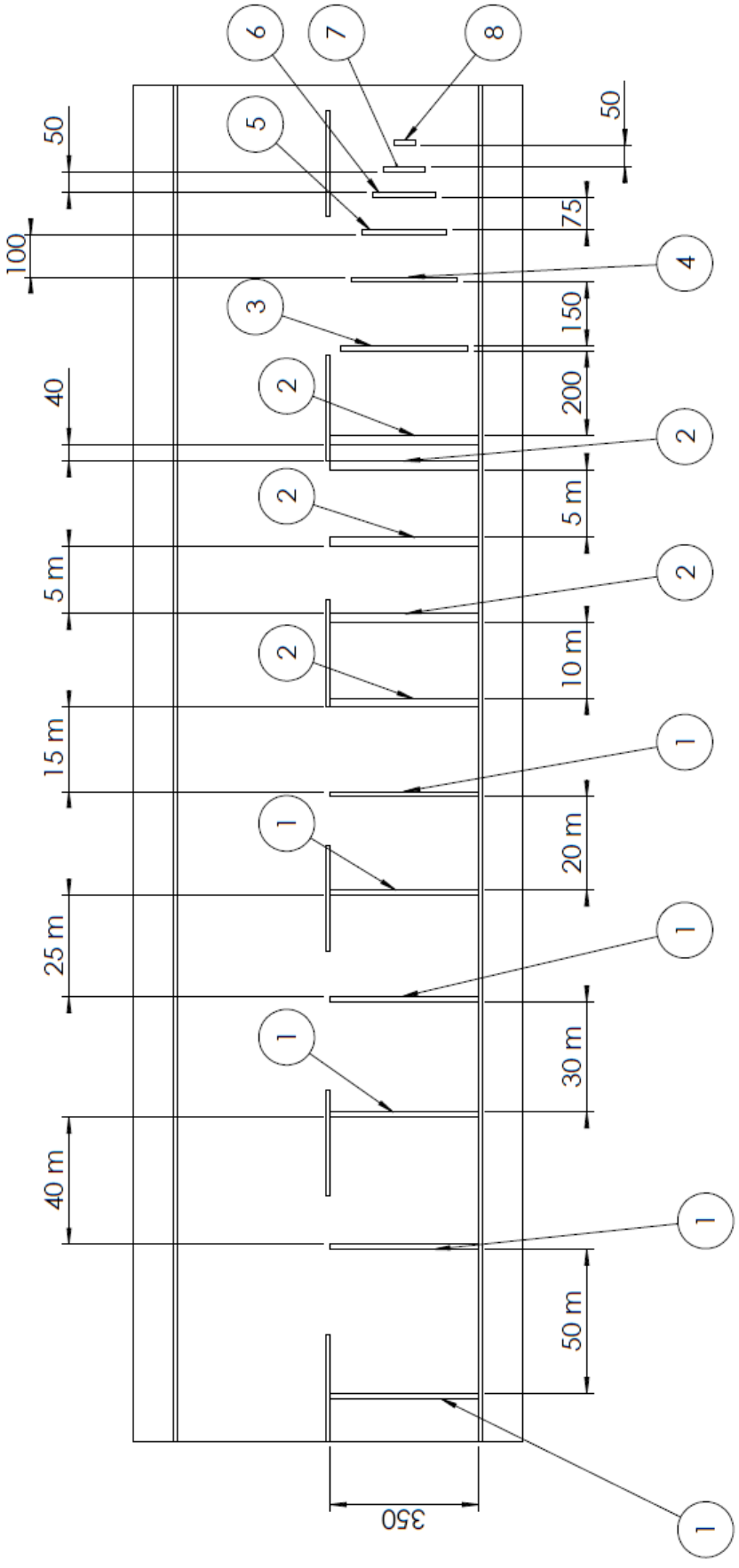
3. Possible proposals

Once explained the current situation of this crossing, some actions are proposed and detailed. The objective is to reduce the number of accidents and to reduce the speed of the drivers in their way along this point.

- The first proposal was to paint **transversal white lines** in the road. The lines would have the same function as the transversal warning lines. There would be painted white road markings in the right lane in each way of the road. The function of these white lines would be warning the drivers that they are coming to a dangerous crossing in which it is necessary to reduce the speed to guarantee the safety in the road. The Illustration 60 shows a virtual picture of how the road would be, and the Illustration 61, shows a sketch of the lines that were proposed to paint.
- The second proposal, and that was complementary to the previous one, was consisted of **lighting the signs** that announce a dangerous crossing. This sign would have the double objective of warning the drivers and explaining why they should moderate the speed and why they should drive with more attention at this point. The Illustration 59 shows an example of the light signs. It is to highlight that in this stretch of the road there is street lighting, from which it might be possible to take the electrical supply.

Illustration 59: Representation of the light sign proposed to warn about a dangerous crossing.

Illustration 60: Virtual picture of how the stretch of the crossing would be with the transversal white lines.



N°	LENGTH (mm)	WIDTH (mm)	COMMENT
1	3500	120	White line
2	3500	200	Transversal alert white line
3	3000	120	White line
4	2500	120	White line
5	2000	120	White line
6	1500	120	White line
7	1000	120	White line
8	500	120	White line

Illustration 61: Sketch of the lines that are proposed to paint in the road.

4. Reason to reject this location

The reasons to reject the possibility of implanting the road safety's campaign in this point are the following:

- According to a study of the statistics of the most serious accidents produced in this point in the last years, it was observed that the principal reasons of these accidents were a combination of speeding, youth and night.

  After studying these data with the experts of Road Safety and with the Service of Conservation, it was obtained as a conclusion that there were very punctual accidents and due to very concrete reasons, which might not be avoided with the implantation of the campaign with the characteristics and objectives of the STARS Project.

- Experts in Road Safety have valued this proposal with other two proposals, coming to the conclusion that this one was not as appropriate as the one that has been selected. In this point it would make less sense to carry out the campaign, due to the fact that the accidents happened, had a very isolated characteristics.

  In the same way, the experts advised the choice of the crossing that gives entry to Falmuria Industrial Park to carry out an initiative, because it was the better stretch in which better solutions were proposed according to the philosophy of the STARS Project.

ANNEX VI: PROPOSAL IN THE STRETCH OF STRAIGHTS

1. Location

This stretch of straights is located between K.P. 7.7 and K.P. 11.5. One of the principal characteristics of this stretch of road is that there are three big straights with brow of hills and wide curves where it is very usual that the drivers exceed the maximum allowed speed. Now the length and the K.P. are detailed for each of the 3 straights, to explain better the location.

- The first straight is located between the kilometre points 7.7 and 9.4. It has a length of 1700 m.

Illustration 62: Satellite sight of the first straight (K.P. 7.7 to K.P. 9.4).

Illustration 63: The first straight.

- The second straight is located between the kilometre points 9.4 and 10.1. His length is 750 m.

Illustration 64: Satellite sight of the second straight (K.P. 9.4 to K.P. 10.1).

Illustration 65: The second straight.

- The third straight is located between the kilometre points 10.2 and 11.5, with a length of 1300 m.

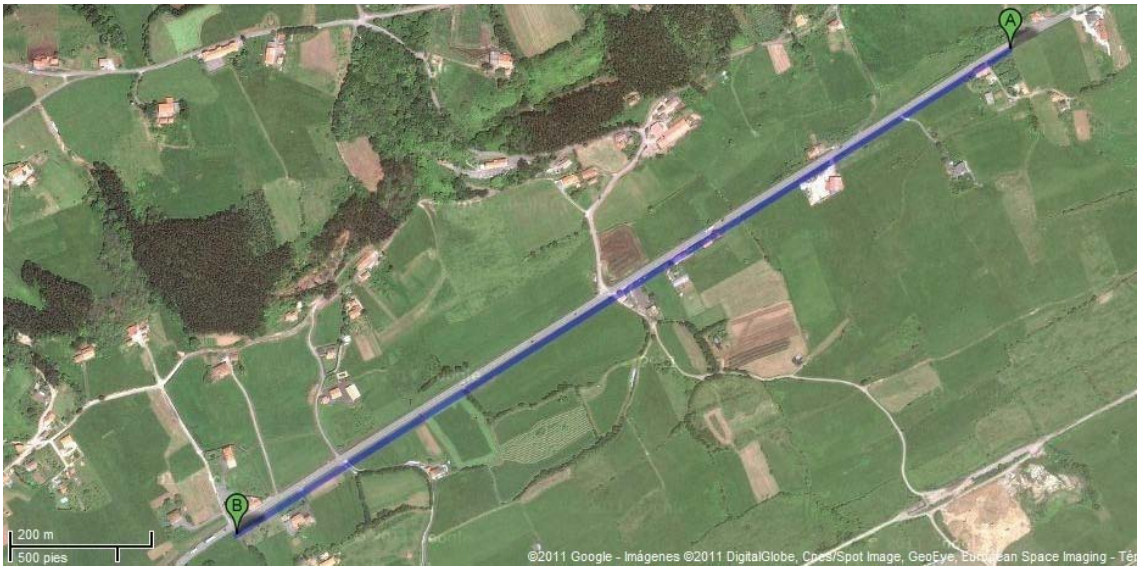


Illustration 66: Satellite sight of the third straight (K.P. 10.2 to K.P. 11.5).

Illustration 67: The third straight.

2. Current situation

In this case there are three long straights in which the maximum speed is limited to a maximum of 90 km/h (+ 20 km/h to overtake). However, due to its long length, it is usual that drivers drive at a speed higher than the allowed.

Apart from its length, these three straights present brows of hills that do that the visibility to overtake in certain points is practically nothing.

All these factors joined to the fact that the road is used especially by people who is working or going and coming from the place of work (habitual drivers), do that hurries and confidence appear. Every day it takes place many manoeuvres that put in danger the safety of the drivers. To understand clearly which these types of situations are, there is an example in the Illustration 68, in which we can see a truck overtaking another one. Although it cannot be seen in the photography, it is possible to image what happened a few seconds after taking the photo: the green truck finished the overtaking in an area where it was not allowed to overtake because of a brow of a hill.

With this situation, it is possible to understand that in this stretch of straights, there is the worst stretch of the road (as for statistics of accidents and seriousness), of between 215 km from roads that have been an object of study for the production of this report.

Illustration 68: Truck overtaking another one (1st straight).

Nowadays, there are drivers who do not obey with the signposting of the road and overtake in inappropriate places, putting in danger their own safety and the safety of the rest of the users of the road. The reason of this type of overtaking, it might be another one apart from the hurries and confidences of the habitual drivers.

Provided that the straights have constant brow of hills (some of them can be seen in the illustrations that accompany this chapter), in occasions there is an optical effect in which the driver can see the part of the straight that has nearby and the final, but does not see an intermediate zone of the straight.

There is the possibility that the drivers do not see with sufficient anticipation the sign of "overtake forbidden", and believe that they have full visibility to do the manoeuvre due to the mentioned optical effect that takes place for the successive brow of hills.

Illustration 69: Overtake forbidden due to a brow of a hill (1st straight).

Illustration 70: Another brow of a hill with a bus stop (3rd straight).

3. Possible proposals

The proposals that are detailed below were proposed to try to improve the present situation. These actions had the aim of reducing the speed in this stretch of straights and decrease the risk of accidents.

- The first proposal suggested a possible improvement to prevent drivers from overtaking in areas of low visibility, due to the brow of hill or the proximity to a fast curve.

  The proposal would have consisted of painting **return arrows** in the road. These arrows would have been placed in the axis of the road and pointing towards the right, announcing the proximity of a continuous line and indicating to the driver that he or she must drive along the right verge.

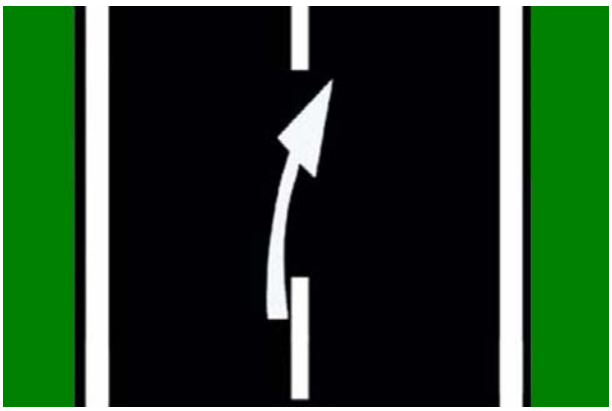


Illustration 71: Sketch of return arrow.

Illustration 72: Example of the application of the return arrows in a road.

- There is also a problem of speeding. This is a stretch with three long straights connected by opened curves, which means that drivers tend to exceed the speed limit.

  The second proposal was destined to make drivers reduce their speed in their way across these straights. The speed is determinant in the seriousness of the accidents. T**he key is to reinforce the informative signs of speed limit, making drivers conscious of their own speed**.

  For this reason, it was proposed to install in the straights, **signs** that were indicating the existence of **speed traps** (as seen in the Illustration 73) and a **driver feedback sign** (as seen in the Illustration 74 and in the Illustration 75) that shows in real-time the speed of a vehicle and if it is exceeding the limit in this stretch. The functioning is simple, the radar of the sign calculates the speed of the vehicle and it is shown in a screen that can be seen more than 100 meters of distance. If it appears in green it means that the driver has not overcome the speed limit for this stretch, and if the colour is red, it means that the speed is higher to the allowed.

Illustration 73: Sign that indicates the existence of a speed trap.

Illustration 74: Example of a driver feedback sign.

Illustration 75: Example of a driver feedback sign and indication of the speed limit.

4. Reason to reject this location

The main reason that made this proposal to be rejected is the economical. The installation of a driver feedback sign needs of a great investment, because it is an equipment of high complexity with a very high cost. Likewise, the fact that it was complex equipment does that it needs of a constant maintenance to guarantee that it is working correctly. It is necessary to do reviews quite often to guarantee that it is good calibrated.

In addition, having installed a driver feedback sign may not obtain an improvement of the safety in the whole stretch. A reduction of the speed would be obtained in the area in which is placing the driver feedback sign. The most probable thing would be that the drivers reduce their speed near the sign, but before and after it, they would drive with the same speed.

This proposal has also been rejected for the same motive than the previous one, as it is possible to see in the section 4 of the Annex V. The experts and persons in charge of Road Safety coincided to point that, in order to take a campaign with the characteristics of the STARS Project, the most suitable, interesting, and economical and technical viable proposal was the one in the Falmuria Industrial Park's crossing.

ANNEX VII: STATISTICAL TABLES AND GRAPHICS

In this annex it is carried out a statistical study of the evolution of the speed as a result of the campaign. The measures have been taken using a radar station that calculates the speed of the vehicles that are driving towards the crossing in the way from Avilés to Gijón. This radar station measures the average speed of a stretch of approximately 50 meters, placed between the exit of the curve and the bus stop. The Illustration 76 shows where the radar station was located.

Illustration 76: Stretch in which the measures of the average speed of the vehicles are taken.

The speed measuring has been carried out between Thursday, 30th of June and Friday, 15th of July. It was taken into account in what days were carried out the actions and the hours in which there have been people or machines working in the stretch. The measuring time has been split into three sets:

★★★★★★★★★★

The statistics have been carried out taking into account a total of 32547 vehicles.

★★★★★★★★★★

- From Thursday, 30th of June to Wednesday, 6th of July.

  These days there have been taken speed measures before the campaign started. There were measured a total of 12425 vehicles during this period. These measures have been taken after doing the maintenance works (pruning and cleaning the weeds, painting the lines, cleaning and repairing the crash barriers). It is wanted that these preliminary tasks which are not specific actions of the campaign, have no influence in the results obtained in the study.

- From Thursday, 7th of July to midday of Wednesday, 11th of July.

  In this period it was measured the speed of 9724 vehicles. These measures have been taken after carrying out all the actions of the campaign, except placing the high visibility panels. In this way, this allows to obtain a few conclusions after the installation of the reflective delineation systems, the "cat's eye" road studs, the crash barrier road studs and the transversal white lines. It is wanted to avoid the influence that the placement of fluorescent reflective panels with a new speed limit would have.

- From Monday afternoon, 11th of July to Friday, 15th of July[1].

  This last set of measures of the speed of the vehicles has been carried out when the campaign had concluded, with the placing of the fluorescent reflective panels with a dangerous crossing sign and a new speed limit. It has been taken measures of a total of 10398 vehicles during this period.

★★★★★★★★★★

Measures have taken in three different periods:

¬ Before starting the labour.
¬ After the first set of actions.
¬ After the campaign.

★★★★★★★★★★

Provided that the weather conditions are an important and influential factor in the speed of the vehicles, it has been taken into account the weather during the days that the speed was measured. The weather has been, in general, a mixture of cloudy and sunny, with slightly rains and some small summer storms. It was observed that the weather has been – more or less – the same during three weeks. **It can be considered that the weather conditions have not had much influence in the results of this study.**

[1] It was initially programmed to carry out speed measures until Monday, 18th of July. However, due to technical problems, measures have only been taken until 15th of July.

The results obtained with the radar station have been downloaded and processed so statistical results could be obtained to value the campaign. Given the great quantity of information, several tables have been done like summary of the information. First, it has been done a few tables in which the following things are taking into account, for each hour and day:

- V_{85}: The 85th percentile speed. It is the speed which 85% of the vehicles driving slower, during a period of time.
- V_{AVE}: It is the average speed of the vehicles that are driving along the stretch, during a period of time.
- V_{MAX}: It is the highest speed registered by all the vehicles in the indicated period. It was seen that this measure was almost random, because it only represents one measure, not the whole sample. For this reason it was decided not to consider this measure in the statistical study and it was only considered the V_{85} and the V_{AVE}.
- Veh: It indicates the number of vehicles that have passed through the stretch, during the indicated period.

The tables that show the information have been separated according to the three measuring periods considered in this project. With the information contained in each of the tables, it has been represented the 85th percentile speed (V_{85}) and the average speed (V_{AVE}) in two graphs for each day. Likewise, the V_{85} and the V_{AVE} have been calculated for each of the considered periods.

Next it is indicated the information that is showed in the tables and graphs of the following pages:

- Table 6: Summary of the speed measures before starting the actions of the campaign.
    - Illustration 77: Graph that shows the 85th percentile speed (V_{85}), for the period before the beginning of the actions of the campaign. Likewise, the average value is showed, considering the 12425 vehicles that have passed through the stretch during this first period.
    - Illustration 78: Graph that shows the average speed (V_{AVE}) of the vehicles that have passed through the stretch during the period previous to the start of the campaign. It is also represented the curve with the speed average value for the 12425 vehicles during all this period.
- Table 7: Summary of the speed measures after carrying out the first set of actions. It only remained the placing of the fluorescent reflective panels.
    - Illustration 79: Graph that shows the 85th percentile speed (V_{85}), for the period after the first actions of the campaign. It remained the placing of the fluorescent reflective panels. Likewise, it is represented the average value considering the 9724 vehicles that have passed through the stretch during this second period.

  - Illustration 80: Graph that shows the average speed (V_{AVE}) of the vehicles that have passed through the stretch during the period after the first actions of the campaign. It remained the placing of the fluorescent reflective panels.

- Table 8: Summary of the speed measures after carrying out all the actions of the campaign.
  - Illustration 81: Graph that shows day by day the 85th percentile speed (V_{85}), for the period after the campaign, after carrying out all the actions. Besides, it is showed the average value considering the 10398 vehicles that have passed through the stretch during this third period.
  - Illustration 82: Graph that shows the average speed (V_{AVE}) of the vehicles that have passed through the stretch during the last period, after carrying out the campaign. It is also represented the curve with the average speed value for the 10398 vehicles measured during this last period.

Once the summed up data for each day was presented, grouped per periods, it was proceeded to compare each period, to be able to quantify the speed variation that has been produced by the campaign. So, it was started by grouping in a table the average speed, the 85th percentile speed and the maximum speed. From this table, it was proceeded to represent in a graphic the data. This shows that a reduction of the speed has been obtained. This speed can be quantified numerically, for it, it was calculated the percentage of the speed reduction that has been obtained with each block of actions. All this information can be seen in the next tables and graphs:

- Table 9: Hourly summary of all the data for the three considered periods: before the campaign, after the first actions, and after the campaign.
  - Illustration 83: Graph that shows, for each considered period, the 85th percentile (V_{85}).
  - Illustration 84: Graph that shows the average speed (V_{AVE}) of the vehicles that have passed through the stretch during each of the considered periods. It is proved that, after the campaign, the average speed of the vehicles has also been reduced.
- Table 10: Summary of the speed values for each considered period. The values for the workings days, the weekends,
- Table 11: Speed reduction percentage after each set of actions and the whole value after the campaign.

	Thursday, 30/06/2011				Friday, 01/07/2011				Saturday, 02/07/2011				Sunday, 03/07/2011				Monday, 04/07/2011				Tuesday, 05/07/2011				Wednesday, 06/07/2011			
Time	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh
0:00	-	-	-	-	92	77	102	14	82	70	97	32	82	74	137	28	82	73	92	27	82	74	97	28	87	77	107	27
1:00	-	-	-	-	82	71	87	10	82	75	102	19	82	75	112	19	82	71	102	18	72	74	102	12	97	85	112	8
2:00	-	-	-	-	82	77	102	17	72	67	87	12	77	69	92	28	77	74	87	12	92	75	107	12	82	71	82	16
3:00	-	-	-	-	92	75	92	16	82	77	107	11	77	73	92	12	82	73	92	11	92	79	97	8	87	74	97	15
4:00	-	-	-	-	102	81	107	15	92	80	117	19	82	72	92	15	97	81	112	17	92	79	112	16	102	83	127	19
5:00	-	-	-	-	92	81	137	118	92	83	112	88	92	82	122	71	92	82	112	115	92	82	117	112	92	81	127	121
6:00	-	-	-	-	87	77	117	125	92	80	102	61	87	80	97	32	92	78	122	125	87	78	107	122	92	78	102	123
7:00	-	-	-	-	-	-	-	-	87	79	102	57	92	79	107	33	82	70	107	225	82	70	102	200	82	71	97	219
8:00	-	-	-	-	-	-	-	-	87	75	112	66	87	75	102	33	82	73	102	146	82	73	102	167	82	71	107	141
9:00	-	-	-	-	-	-	-	-	82	76	107	64	87	76	112	43	82	70	97	122	77	70	92	134	82	69	102	141
10:00	-	-	-	-	-	-	-	-	87	73	97	72	87	75	107	49	82	70	97	120	82	70	92	142	-	-	-	-
11:00		-	-	-	-	-	-	-	87	75	112	90	82	75	107	65	82	70	97	146	82	70	92	173	-	-	-	-
12:00	-	-	-	-	-	-	-	-	87	75	107	107	87	74	102	82	82	72	102	126	82	71	97	148	-	-	-	-
13:00	-	-	-	-	82	72	107	166	87	78	117	130	92	79	122	122	82	73	102	145	87	74	112	164	-	-	-	-
14:00	87	74	112	158	82	71	102	160	87	77	102	102	92	77	107	79	87	73	107	134	87	75	112	147	-	-	-	-
15:00	82	71	97	153	82	72	107	129	87	78	117	63	82	73	122	41	82	72	107	156	87	74	97	156	-	-	-	-
16:00	82	71	102	138	82	70	107	121	87	74	107	80	82	74	97	81	77	69	107	132	82	72	107	140	-	-	-	-
17:00	82	72	107	166	87	72	122	159	82	75	97	80	82	74	97	87	82	70	102	154	82	71	107	155	-	-	-	-
18:00	82	70	102	162	82	70	102	156	87	76	102	87	87	75	107	115	82	72	117	145	82	71	107	149	-	-	-	-
19:00	82	74	102	163	87	75	112	147	82	73	92	103	87	75	122	124	82	73	102	163	87	73	117	143	-	-	-	-
20:00	87	75	102	135	87	75	107	114	87	76	112	146	87	75	97	131	82	74	127	117	87	76	117	101	-	-	-	-
21:00	87	78	117	114	92	77	112	124	87	79	147	126	87	78	107	152	92	80	117	145	92	81	117	123	-	-	-	-
22:00	92	80	117	81	87	76	117	80	82	72	97	78	92	76	107	95	87	76	117	70	92	80	117	65	-	-	-	-
23:00	82	73	122	35	87	73	112	54	82	71	107	43	87	76	112	52	87	76	107	25	87	79	97	27	-	-	-	-
Total	**84**	**73**	**122**	**1305**	**86**	**74**	**137**	**1725**	**86**	**76**	**147**	**1736**	**87**	**76**	**137**	**1589**	**84**	**73**	**127**	**2596**	**85**	**74**	**117**	**2644**	**86**	**74**	**127**	**830**

Table 6: Summary of the speed measures before starting the actions of the campaign.

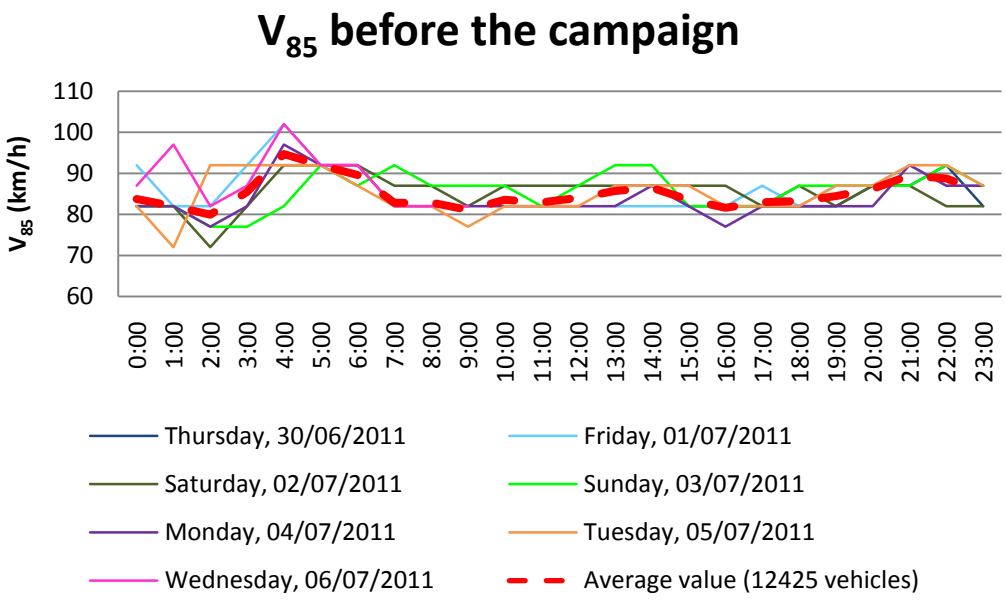


Illustration 77: Graph that shows the 85th percentile speed (V_{85}), for the period before the beginning of the actions of the campaign. Likewise, the average value is showed, considering the 12425 vehicles that have passed through the stretch during this first period.

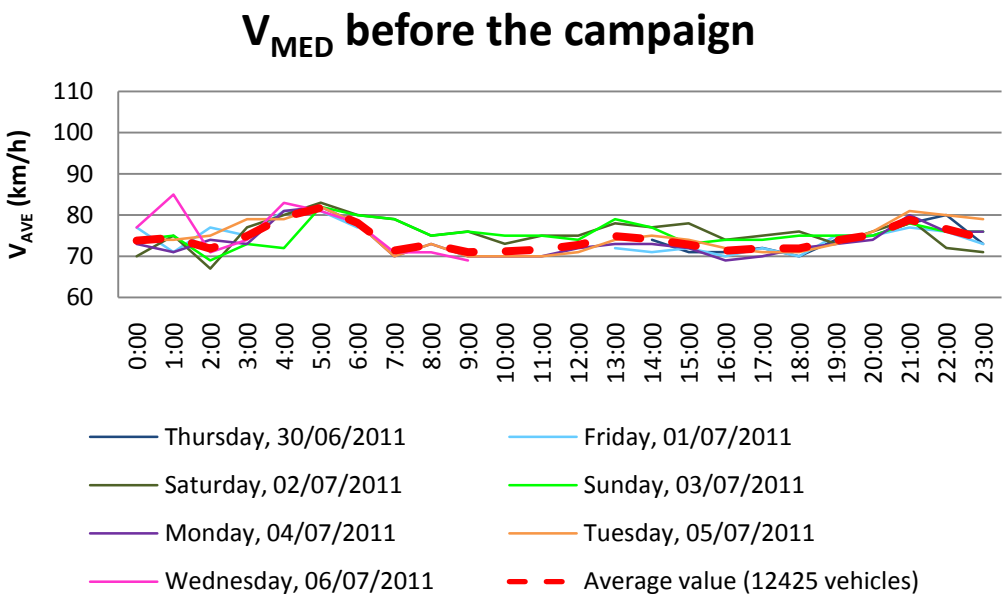


Illustration 78: Graph that shows the average speed (V_{AVE}) of the vehicles that have passed through the stretch during the period previous to the start of the campaign. It is also represented the curve with the speed average value for the 12425 vehicles during all this period.

Time	Thursday, 07/07/2011				Friday, 08/07/2011				Saturday, 09/07/2011				Sunday, 10/07/2011				Monday, 11/07/2011			
	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh
0:00	82	68	92	26	82	70	87	28	77	65	97	26	72	63	82	27	87	72	92	18
1:00	72	68	77	6	87	73	92	10	67	67	92	14	72	64	82	18	67	65	82	12
2:00	72	67	82	9	72	65	77	9	72	66	77	11	72	66	77	16	67	64	72	12
3:00	77	73	97	11	82	73	97	8	77	69	77	11	77	69	77	12	72	67	72	11
4:00	87	72	97	14	92	76	107	16	92	74	97	18	82	70	82	11	82	75	107	17
5:00	87	76	112	106	87	77	107	107	87	78	102	71	82	72	87	52	82	71	97	93
6:00	87	72	107	120	87	73	112	125	82	75	102	52	77	69	87	34	77	69	92	101
7:00	77	66	97	221	77	69	102	220	87	75	107	61	87	75	102	16	77	66	87	241
8:00	77	67	87	150	77	69	112	147	82	72	97	48	82	71	92	26	77	67	92	137
9:00	72	65	87	120	77	66	92	112	82	69	97	47	77	67	97	34	77	66	97	112
10:00	77	66	92	133	72	65	92	128	77	70	92	61	82	70	92	34	77	67	87	139
11:00	72	64	107	119	77	65	97	150	82	71	97	81	77	70	102	55	77	65	102	141
12:00	77	65	92	138	72	66	102	125	82	71	107	107	82	71	102	80	77	67	102	138
13:00	82	69	97	167	77	70	102	168	82	75	107	132	87	76	112	114	82	69	107	151
14:00	77	67	92	154	77	68	107	160	82	72	97	76	87	74	97	68	82	69	102	140
15:00	77	66	107	150	77	69	102	153	82	71	92	61	82	72	97	43	82	69	102	156
16:00	72	65	87	133	77	66	92	145	82	69	92	69	82	70	92	78	-	-	-	-
17:00	77	66	97	172	77	67	117	135	77	68	97	78	77	70	97	89	-	-	-	-
18:00	77	66	97	152	77	68	92	143	77	70	97	86	82	71	107	99	-	-	-	-
19:00	77	70	107	146	77	70	92	132	77	69	92	105	82	71	117	100	-	-	-	-
20:00	82	71	102	113	82	71	92	121	77	69	102	91	82	71	102	114	-	-	-	-
21:00	82	73	112	141	87	76	112	136	77	69	102	126	87	73	97	138	-	-	-	-
22:00	82	71	102	73	77	68	92	64	77	65	87	66	82	70	92	67	-	-	-	-
23:00	92	76	112	34	77	66	92	33	72	65	97	51	82	71	102	48	-	-	-	-
Total	**78**	**68**	**112**	**2608**	**78**	**69**	**117**	**2575**	**80**	**71**	**107**	**1549**	**82**	**71**	**117**	**1373**	**79**	**68**	**107**	**1619**

Table 7: Summary of the speed measures after carrying out the first set of actions. It only remained the placing of the fluorescent reflective panels.

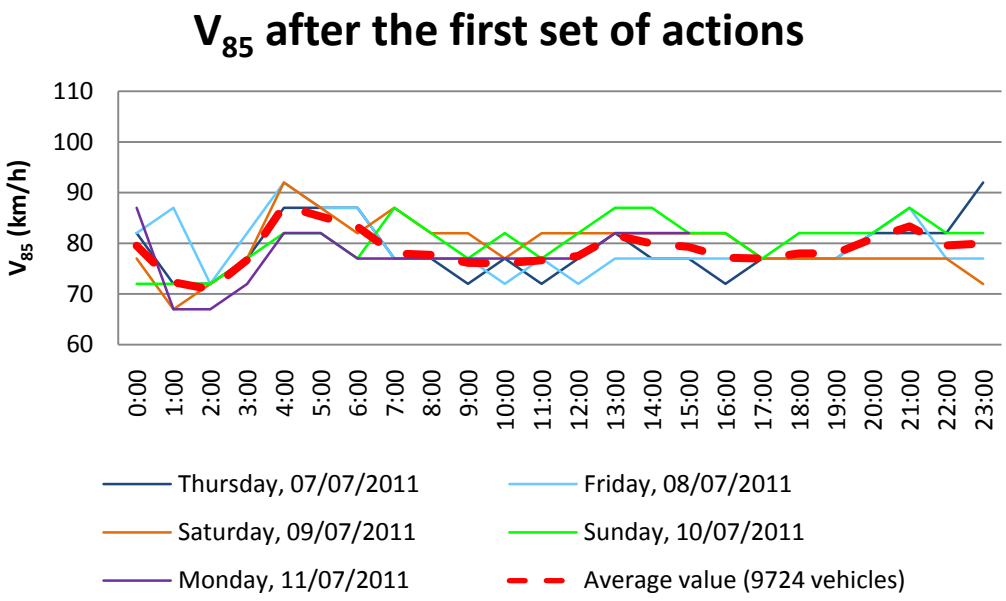


Illustration 79: Graph that shows the 85th percentile speed (V_{85}), for the period after the first actions of the campaign. It remained the placing of the fluorescent reflective panels. Likewise, it is represented the average value considering the 9724 vehicles that have passed through the stretch during this second period.

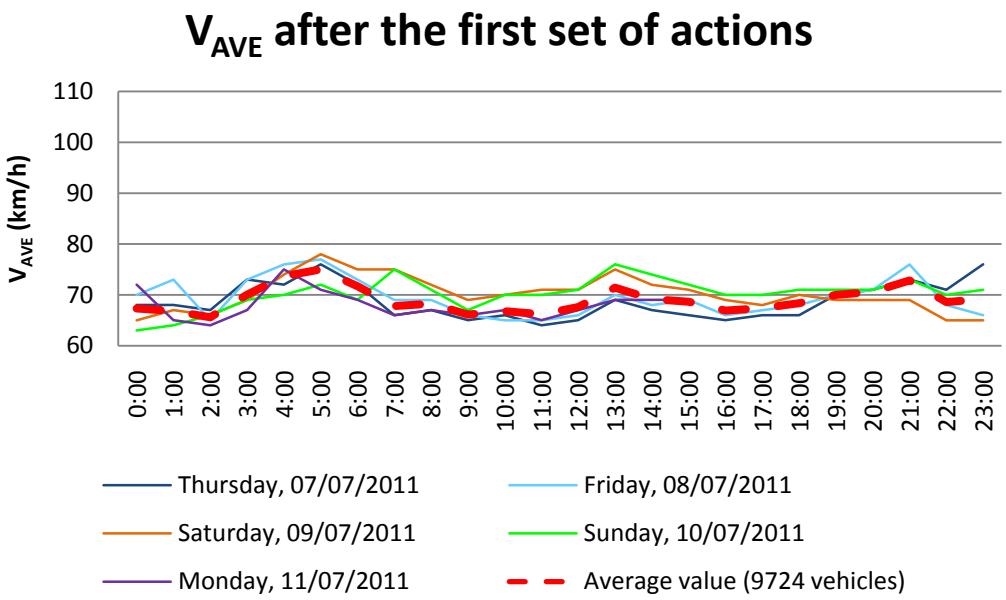


Illustration 80: Graph that shows the average speed (V_{AVE}) of the vehicles that have passed through the stretch during the period after the first actions of the campaign. It remained the placing of the fluorescent reflective panels. The curve with the average value for the 9724 vehicles is also showed for this period.

Time	Monday, 11/07/2011				Tuesday, 12/07/2011				Wednesday, 13/07/2011				Thursday, 14/07/2011				Friday, 15/07/2011			
	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh
0:00	-	-	-	-	82	69	87	21	82	68	87	16	77	68	92	33	82	68	102	34
1:00	-	-	-	-	77	73	87	5	72	64	77	5	92	76	97	14	82	73	112	12
2:00	-	-	-	-	72	69	82	11	72	66	72	9	77	71	82	12	72	70	77	8
3:00	-	-	-	-	77	73	132	15	72	66	72	9	77	73	82	11	82	73	97	14
4:00	-	-	-	-	82	74	97	17	72	68	102	14	92	79	107	17	82	74	102	15
5:00	-	-	-	-	82	74	102	92	87	74	102	85	92	77	102	101	87	75	112	99
6:00	-	-	-	-	82	71	102	107	82	71	92	122	82	72	97	111	87	73	102	131
7:00	-	-	-	-	72	61	82	173	77	65	92	216	77	66	107	210	77	68	107	216
8:00	-	-	-	-	72	63	87	122	72	65	102	137	77	69	97	141	77	67	102	142
9:00	-	-	-	-	67	61	87	86	72	64	92	124	77	66	107	117	77	65	87	124
10:00	-	-	-	-	72	63	82	118	72	64	87	115	77	67	107	137	72	64	97	135
11:00	-	-	-	-	72	64	87	137	72	64	82	134	72	66	87	113	77	65	92	124
12:00	-	-	-	-	72	64	92	145	72	64	82	151	72	66	107	135	72	64	87	144
13:00	-	-	-	-	72	62	82	121	77	67	102	166	77	67	102	164	82	68	102	161
14:00	-	-	-	-	72	65	92	134	77	66	102	128	77	67	97	140	72	64	107	164
15:00	-	-	-	-	72	63	97	99	77	66	102	138	77	67	97	133	77	68	122	127
16:00	-	-	-	-	72	62	87	121	72	65	107	134	77	66	87	149	77	66	97	139
17:00	-	-	-	-	77	66	87	164	77	65	97	166	77	68	97	154	77	67	97	158
18:00	-	-	-	-	77	66	92	157	77	67	97	150	77	66	102	158	77	68	102	141
19:00	77	65	92	113	77	69	122	149	77	70	112	155	77	70	102	152	77	68	102	131
20:00	77	68	97	112	82	70	107	108	82	71	92	112	82	69	92	119	82	70	117	133
21:00	82	71	102	113	82	71	97	120	87	74	112	123	82	73	107	131	82	73	107	130
22:00	82	72	102	70	82	72	122	65	82	71	92	75	82	71	107	73	82	72	102	60
23:00	77	69	97	30	82	70	97	31	87	73	107	30	82	73	102	25	77	69	82	36
Total	**79**	**69**	**102**	**438**	**75**	**66**	**132**	**2318**	**77**	**67**	**112**	**2514**	**78**	**68**	**107**	**2550**	**78**	**68**	**122**	**2578**

Table 8: Summary of the speed measures after carrying out all the actions of the campaign.

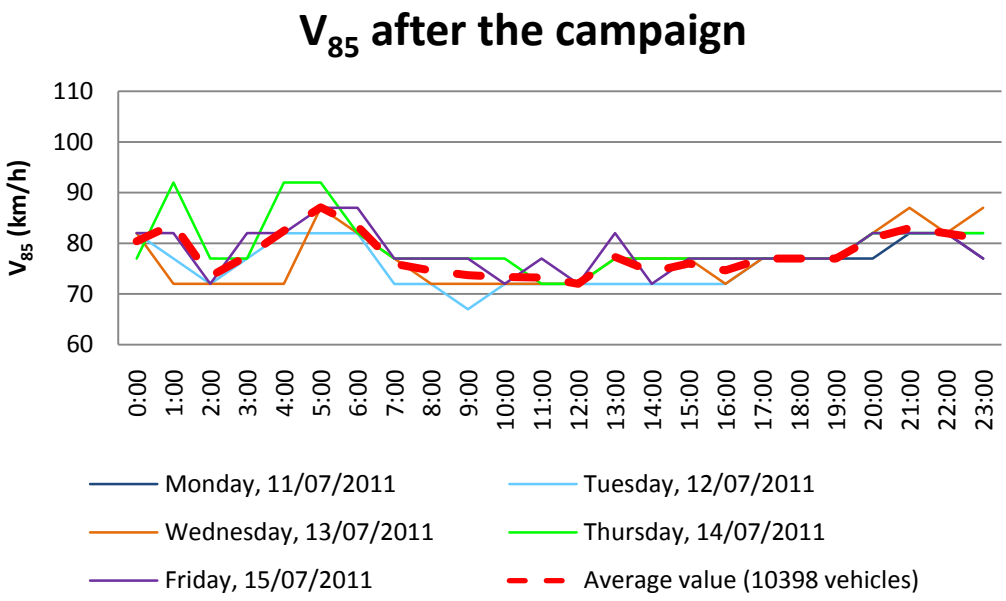


Illustration 81: Graph that shows day by day the 85th percentile speed (V_{85}), for the period after the campaign, after carrying out all the actions. Besides, it is showed the average value considering the 10398 vehicles that have passed through the stretch during this third period.

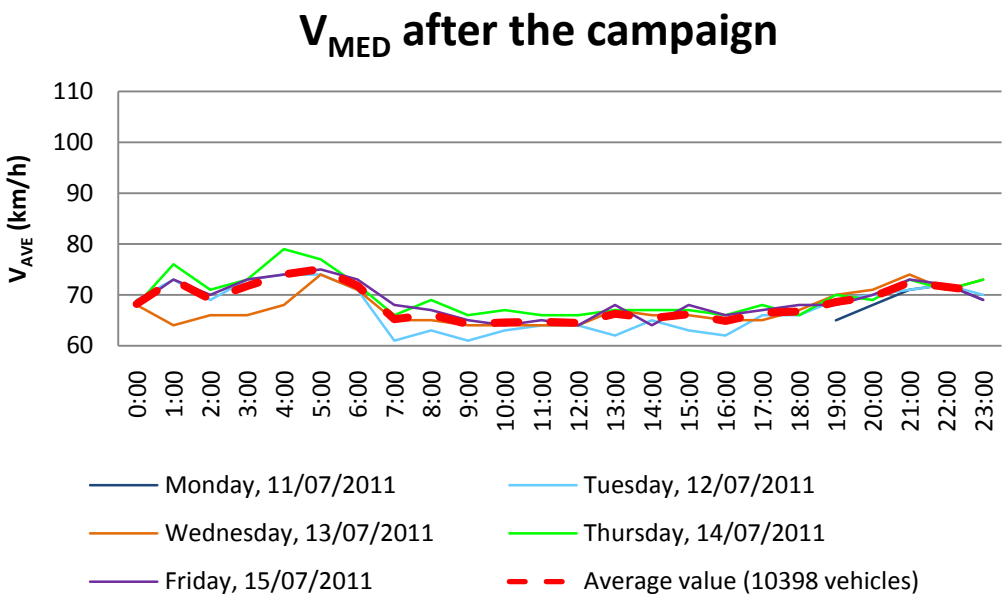


Illustration 82: Graph that shows the average speed (V_{AVE}) of the vehicles that have passed through the stretch during the last period, after carrying out the campaign. It is also represented the curve with the average speed value for the 10398 vehicles measured during this last period.

Summary of statistics												
	Before the campaign				After first set of actions				After the campaign			
Time	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh	V_{85}	V_{AVE}	V_{MAX}	Veh
0:00	84	74	137	156	80	67	97	125	80	68	102	104
1:00	82	74	112	86	72	67	92	60	84	73	112	36
2:00	80	72	107	97	71	66	82	57	74	69	82	40
3:00	85	75	107	73	77	70	97	53	78	72	132	49
4:00	95	80	127	101	87	74	107	76	82	74	107	63
5:00	92	82	137	625	85	75	112	429	87	75	112	377
6:00	90	78	122	588	83	72	112	432	83	72	102	471
7:00	83	71	107	734	78	68	107	759	76	65	107	815
8:00	83	73	112	553	78	68	112	508	75	66	102	542
9:00	81	71	112	504	76	66	97	425	74	64	107	451
10:00	84	71	107	383	76	67	92	495	73	65	107	505
11:00	83	72	112	474	77	66	107	546	73	65	92	508
12:00	84	73	107	463	78	68	107	588	72	64	107	575
13:00	86	75	122	727	82	71	112	732	77	66	102	612
14:00	86	74	112	780	80	69	107	598	74	65	107	566
15:00	84	73	122	698	79	69	107	563	76	66	122	497
16:00	82	71	107	692	77	67	92	425	75	65	107	543
17:00	83	72	122	801	77	67	117	474	77	66	97	642
18:00	83	72	117	814	78	68	107	480	77	67	102	606
19:00	84	74	122	843	78	70	117	483	77	69	122	700
20:00	86	75	127	744	81	71	102	439	81	70	117	584
21:00	90	79	147	784	83	73	112	541	83	72	112	617
22:00	89	77	117	469	80	69	102	270	82	72	122	343
23:00	85	74	122	236	80	69	112	166	81	71	107	152
Total	85	74	147	12425	79	69	117	9724	77	67	132	10398

Table 9: Hourly summary of all the data for the three considered periods: before the campaign, after the first actions, and after the campaign.

In the Table 9 it is possible to see that, the value of the maximum speeds is practically random along the whole campaign. This is due to the fact that between a high number of vehicles that drive along the stretch, there are always someone that drives with a excessively high speed. However, what is really important is to manage a reduction of a high percentage of vehicles (85% in this study).

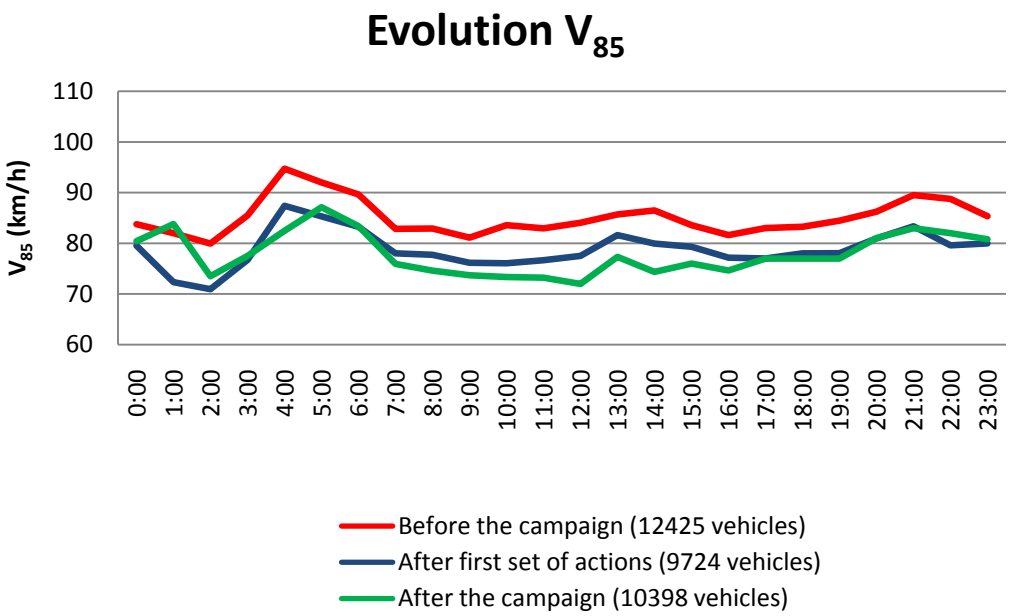


Illustration 83: Graph that shows, for each considered period, the 85th percentile (V_{85}). It is possible to see that the speed of the vehicles has been reduced after carrying out the actions of the campaign.

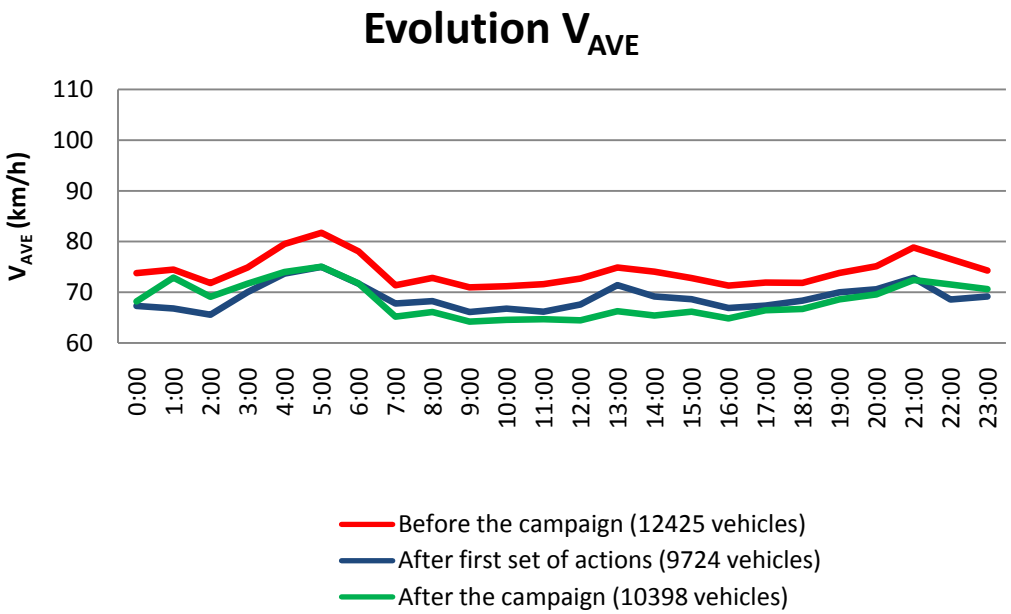


Illustration 84: Graph that shows the average speed (V_{AVE}) of the vehicles that have passed through the stretch during each of the considered periods. It is proved that, after the campaign, the average speed of the vehicles has also been reduced.

Values before the campaign			
Working days			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
85	73	137	9100
Weekend			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
87	76	147	3325
TOTAL			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
85	**74**	**147**	**12425**
Values after the first set of actions			
Working days			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
78	68	117	6802
Weekend			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
81	71	117	2922
TOTAL			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
79	**69**	**117**	**9724**
Values after the campaign			
Working days			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
77	67	132	10398
Weekend			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
-	-	-	-
TOTAL			
V_{85}	V_{AVE}	V_{MAX}	No. Vehicles
77	**67**	**132**	**10398**

Table 10: Summary of the speed values for each considered period. The values for the workings days, the weekends[1], and the global computation have been taken into account.

[1]As it was said before, the study with the data of the weekends after the campaign could not have been completed, due to technical problems that have impeded the measuring of the speed the last days that were expected.

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Speed reduction	
After the first actions	
V_{85}	7,0%
V_{AVE}	6,8%
After placing the sign	
V_{85}	2,4%
V_{AVE}	2,4%
TOTAL with the campaign	
V_{85}	9,2%
V_{AVE}	9,1%

Table 11: Speed reduction percentage after each set of actions and the whole value after the campaign.

Taking into account the statistical speed study, it can be summed up the following numeric conclusions that have been obtained:

- *The speed of the vehicles, after the implantation of the first part of the campaign has been reduced 7 %.*
- *The speed of the vehicles, after the implantation of the second part of the campaign has been reduced 2.4 %.*
- *The speed of the vehicles, considering all the actions of the campaign together has been reduced 9.2 %.*