MONITORING OF CONCESSION CONTRACTS FOR FIRST GENERATION HIGHWAYS IN SPAIN

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ABSTRACT

Concession contracts for first generation highways (constructed under the first highway plan 1980-1990) constitute the first steps taken by the Spanish Ministry of Public Works and Highways in the field of public/private sector collaboration in order to develop and modernize the basic infrastructures needed for coordinating the economic activities of the country.

This paper will set out the management systems being put in place by FERROSER In AUTOVÍA DE ARAGÓN SOCIEDAD CONCESIONARIA, S.A., bid winner of the “Public Works Concession Contract for the Conservation and Exploitation of the A-2 highway, from kilometer mark 232.8 to kilometer mark 340.0, key AO-Z-26”

The management systems set forth in the contract control three fundamental aspects:

TRAFFIC: Data obtained by means of an automatic traffic-flow measuring system are managed by the program TRAFICO.

COMPREHENSIVE INFRASTRUCTURE MANAGEMENT: Conservation and exploitation activities are managed and controlled, both operationally and economically, by use of the various INFOCOEX modules.

INDICATORS: An in-house application for gathering data, called INDICASER, is available for contract managers and Ministry of Public Works and Highways engineers to evaluate the degree of compliance with condition and quality of service indicators.

1. TRAFFIC

1.1. Introduction.

The management, analysis and handling of traffic data obtained by the 22 traffic data collection points (TDCPs) spread out along the stretch of highway (11 belonging to the Concessionaire and 11 belonging to the Ministry of Public Works and Highways) is carried out by the in-house designed TRAFICO application. Said management is a fundamental part of the contract due to the fact that the government administration uses a concessionaire retribution system known as "Shadow Toll", whereby the concessionaire receives royalties based on the amount of traffic recorded on the section of road in question.

1.2. Operation.

The program has various different functions which are accessed by clicking on the tabs: DAILY, DAY/MONTH, MONTHLY, EXERCISE, ACCUMULATED, PERIOD, STATISTICS, MODEL and EDIT.

1.2.1. Daily

From this tab we can check the daily counts for the last 15 days, sorted in different ways:

Sorted by TDCP: shows a graph and table of daily data sorted by light vehicles, heavy vehicles and totals from each of the TDCPs on the highway section.

Sorted by highway subsection: shows a table and graph of daily data sorted by light vehicles, heavy vehicles and totals for each of the 4 highway subsections.

Comparison with Ministry data: shows a comparison of traffic data recorded by each of the Concessionaire's TDCPs and counts made by the TDCPs of the Ministry.

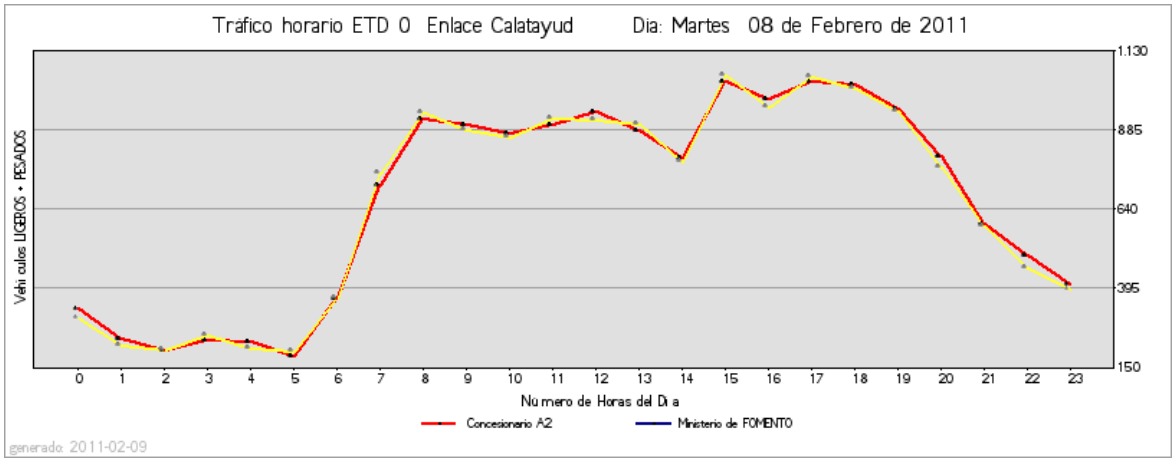


Figure 1 – Daily Graph

1.2.2. Day/Month

List of monthly traffic with daily detail which shows the ADT (Average Daily Traffic) for light vehicles, heavy vehicles and evolution compared with the same month of the previous year for the selected TDCP or highway subsection and period. There are several filters available:

Concession: Displays the Concession's adjusted traffic data compared with the selected TDCP or highway subsection.

Ministry: Displays the ADT for the selected month, comparing data for light vehicles, heavy vehicles and monthly totals with data recorded by the Ministry's TDCPs.

Compared: Carries out a comparison of the data recorded by the TDCP or selected highway subsection with data recorded for the same period the previous year.

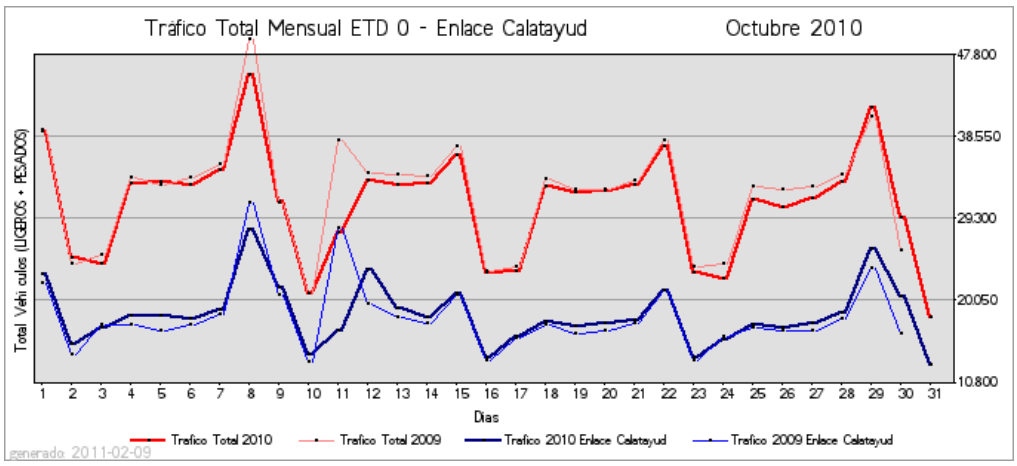


Figure 2 – Comparative Graph

1.2.3. Monthly

Calculates the monthly AADT per TDCP, including its weighted share in the total for the selected month or year.

1.2.4. Fiscal Year

Displays the AADT histogram per month, TDCP and fiscal year. The graph options can be filtered by light vehicles, heavy vehicles or equivalents.

1.2.5.Accumulated

Displays the accumulated AADT histogram per month and TDCP in the last 12 months. The graph can be displayed selecting light vehicles, heavy vehicles or equivalents.

1.2.6.Period

This section analyzes the daily or hourly vehicular traffic distribution per TDCP, highway subsection or the whole highway section.

1.2.7.Statistics

Displays the Maximum/Minimum AADT for the hour/day of the selected year, as well as the Average Distribution Value (Percentage of days of the fiscal year with an ADT of a selected range.

1.2.8. Model

This section compares the actual recorded traffic data with each of the TDCPs and highway subsections for the specified period.

1.2.9. Edit

There may occasionally be data loss or counting errors due to TDCPs breaking down or sensors breaking. This data is manually entered into the program using specific coefficients, modifying the program with the corrected and validated data and updating the database at the same time.

2. COMPREHENSIVE INFRASTRUCTURE MANAGEMENT: INFOCOEX

2.1. Inventory Management: SIMC4.

With GIS map on which linear referencing capacities, layers, different symbols for each element, etc. are applied. It has a video made up of stills taken every 10 meters and covers every road surface and on/off ramp of the highway section. It is synchronized with the section's cartography in such a way that what is seen in the image corresponds with the floor plan displayed on the screen at that moment. It permits auxiliary layers to be inserted in order to support and supplement the information displayed (DXF, DWG y SHP).

Its main functions are: managing inventoried elements, determining quantities of each type of inventoried element, placing each element on a GIS map, displaying images of each element, importing massive quantities of data from CAD files, generating reports for each element and monitoring the history of each inventoried element.

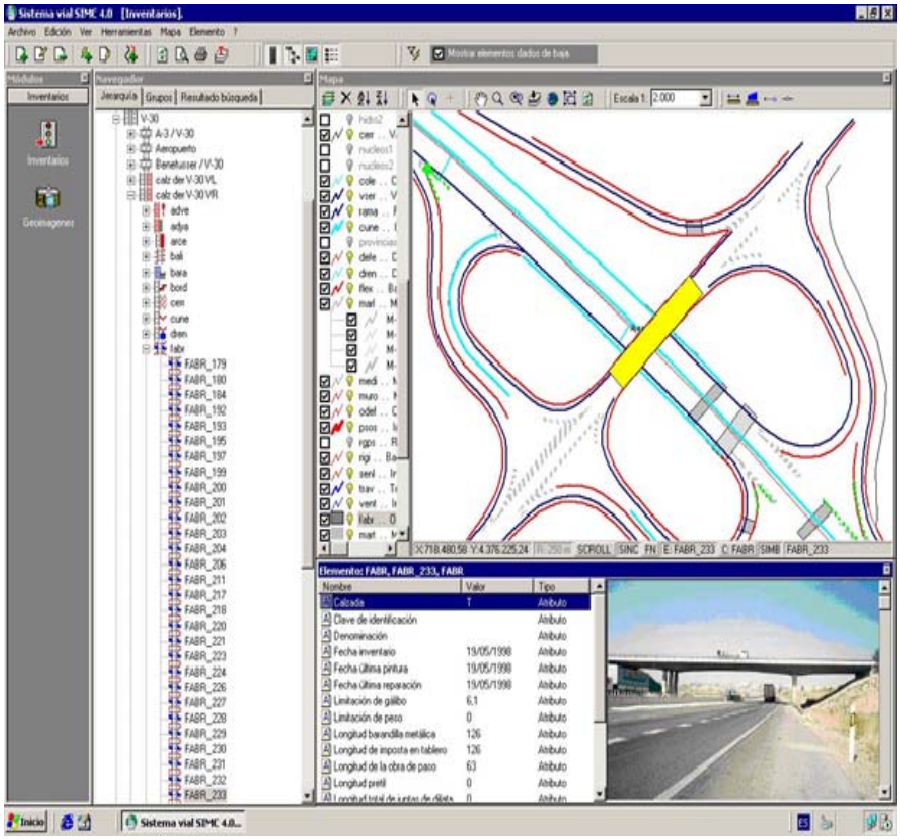


Figure 3 – Video associated with graphic inventory.

2.2. Incident and Advisory Management: ECO

ECO is a module for recording and managing events occurring on the highway which affect operating ability. It is accessed by means of an online application and is therefore easy to access from any terminal with internet connection.

Data is received from various available information systems (Highway Security, Traffic Police, 911, Work Teams, Roadside Assistance Workers, etc). The program can receive images and videos in real-time from Highway Security cell phones and therefore the actual situation at any incident location can be monitored from any internet access point. Digital camera pictures can later be linked to as well.

Figure 4 – Images linked to an incident

Recorded advisories are classified by protocols, which are then further divided into events. There is a specific protocol to be applied for each of these. This way, ECO is able to provide a record of both active and historical incidents, advisories and communications , a description of the actions taken for each of them, images linked to the advisories and notify about advisories via text message.

The advisories recorded here may prompt "Corrective Maintenance" type work orders which are generated in the module "Management of Works and Operating Costs".

The location of maintenance vehicles linked to an advisory can be consulted by means of the license plate numbers using the module "Fleet Management and Winter Highway Administration".

Some of the recorded incidents directly affect the infrastructure elements in inventory. This will be reflected in the module "Inventory Management".

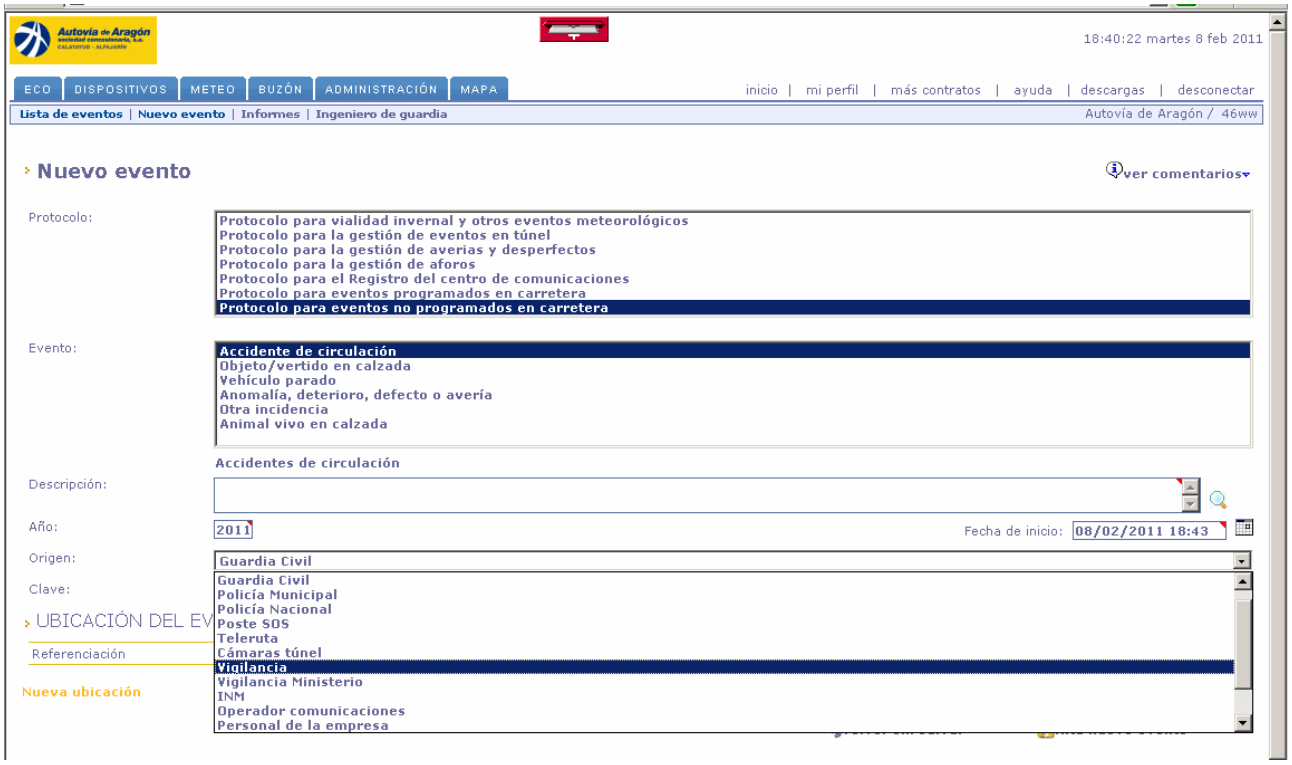


Figure 5 – Incident or Advisory Classification

2.3. Management of Works and Operating Costs: MAXIMO.

A customized program has been developed from a commercial linear assets management product, MAXIMO, for managing inventory, works, inspections, supervising, personnel and warehouse.

The Management of Works and Operating Costs program organizes each object to be maintained into elements or assets. Assets are defined as the main items whose costs we wish to control, coinciding with the "most expensive" functions: road surface, structure, etc. Elements are defined as those objects which do not require individualized cost control but which we do wish to identify in inventory (vertical signs, metal barriers, signaling devices, ...) and whose costs report to the asset directly above.

The Work Orders (WO) which are generated can be PREVENTIVE, CORRECTIVE or INSPECTION types.

2.3.1. Corrective Actions.

Corrective actions are those which result from either an accident or incident that causes damage to the infrastructure or from an inspection which detects damages that need repairing. They are unplanned tasks by definition..

Work orders are created based on previously established work plans which set forth the tasks to be carried out, the forecasted resources (personnel, machinery, material and external services), the affected element or asset, its location and the fault or problem detected.

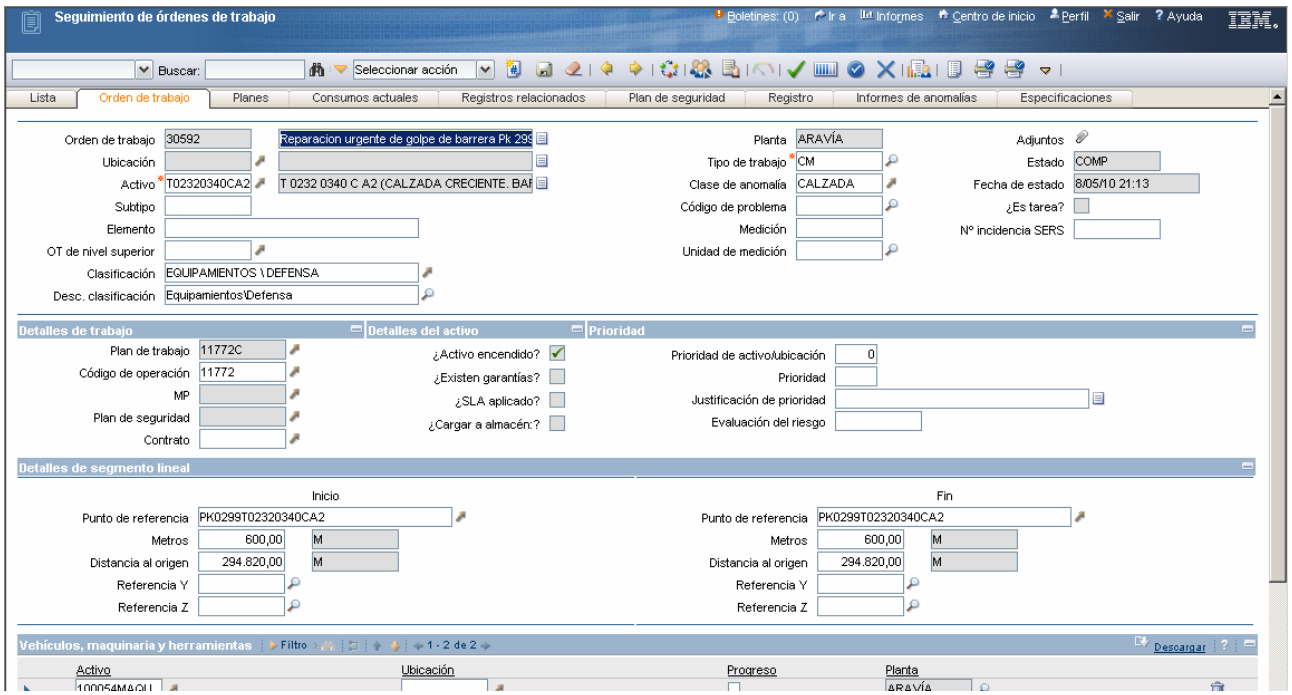


Figure 6 – Corrective Work Order

Those incidents with infrastructure damage recorded in the module "Incident and Advisory Management" will generate corrective type work orders.

2.3.2. Preventive Actions.

Preventive actions are those which are carried out on assets or elements in a planned, systematic fashion. These actions are planned with a specific frequency in such a way that the program will automatically generate the corresponding work orders based on previously established work plans at a preset time, indicating the tasks to be performed, the forecasted resources (personnel, machinery, material and external services), the asset or element affected and its location.
Adequate planning of preventive actions, in compliance with the periodicity defined in the bid specifications, current legislation, user manual or maintenance plans of the company itself will result in a reduction of costs, due to fewer breakdowns, a higher level of service resulting from minimizing interruptions to said service and an optimized useful life of those infrastructure elements subject to preventive maintenance.

2.3.3. Inspections.

Inspections are defined as any jobs meant to review the state of a specific infrastructure element, following a predefined set of inspection points and which the person carrying them out must later write down and record. Inspections may be ordinary or extraordinary. Ordinary inspections are planned and carried out systematically, whereas extraordinary inspections are carried out on an element after an incident has occurred to check whether there are more anomalies that need to be corrected.

Carrying out inspections in compliance with the periodicity defined in the bid specifications, current legislation, user manual or maintenance plans of the company itself is a basic task for maintaining the infrastructure within the required parameters of quality, safety and user-comfort, as it is the mechanism which allows us to know the condition of the inspected asset or element, ensuring that it meets requirements and generating corrective work orders in order to bring it up to standard if deficiencies are noticed during inspection.

One of the most important inspections to be performed is on any bridges located on the highway section. After field work is carried out, the data is input into the Ministry of Public Works and Highways' SGP program. Each bridge is assigned a code, a description, referenced with respect to the highway and in UTM coordinates, a set of files referring to the condition of its elements (piles, abutments, deck, drainage, barrier rails, etc) is filled out and a picture linked to each of these elements.

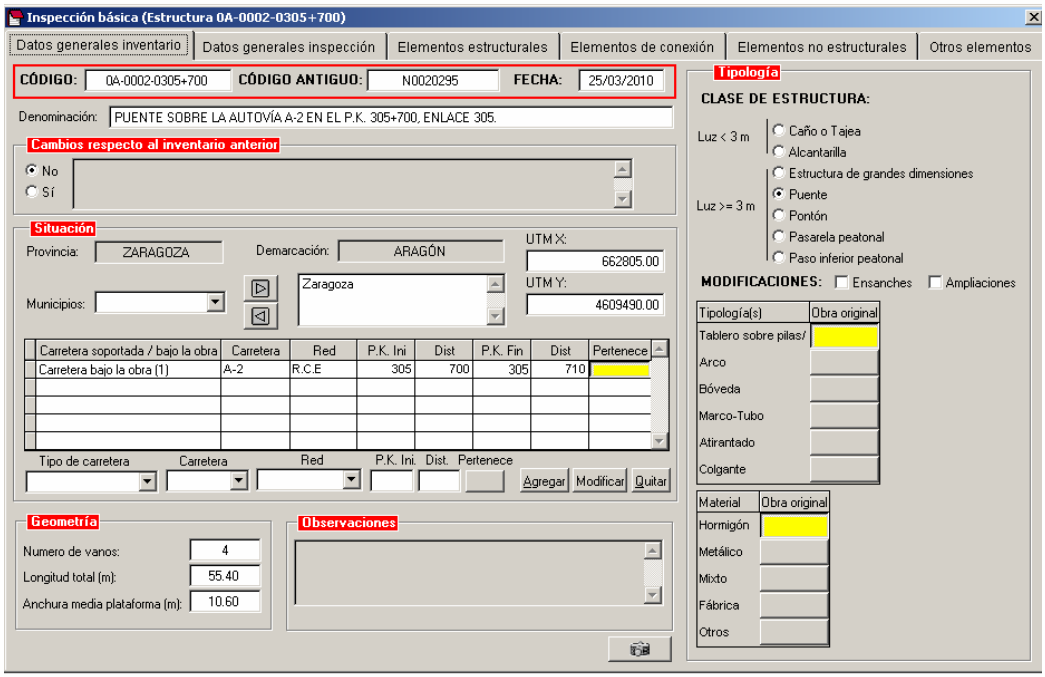


Figure 7 –SGP Inspection File

Figure 8 –SGP Inspection File pictures.

2.4. Fleet Management.

This module is based on GPS positioning. It is used to control the location of the concessionaire's fleet of vehicles at all times. The program has some functions which are common to the whole fleet and others specifically for specialized winter highway administration machinery.

Figure 9 –GPS Positioning map.

2.4.1. Common functions for the whole fleet.

Map included for displaying the geographic location of the vehicles. The program can display the characteristics of each of them on-screen, as well as their location in real-time, routes travelled, reports on these routes (stops, length of stops, condition, ...). Each type of vehicle is represented by a different icon. This system provides a quick visual reference of what each vehicle is doing.

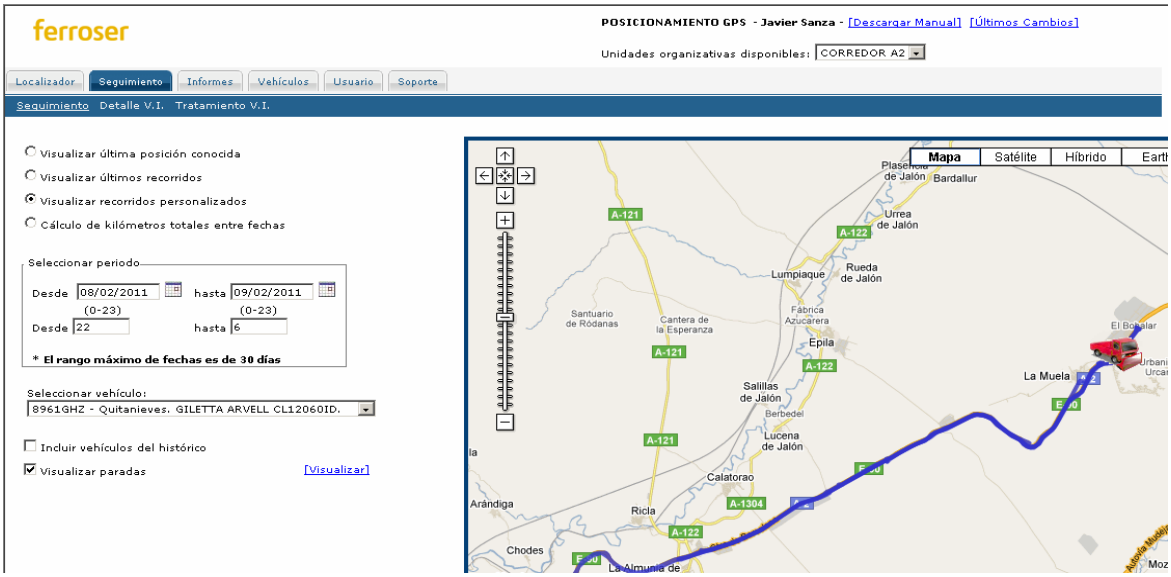


Figure 10 – Fleet Management module interface.

Locator: For determining actual vehicle location as well as possible routes from this point to other selected points.

Monitoring: For determining the routes travelled by each vehicle. The period for which the route travelled needs to be known can be defined as either hourly or daily.

Reports: Provides information about routes travelled, including stops made, length of stops, time used to cover the route and all other route related data. This data can be displayed on-screen or exported as a .pdf report.

Vehicles: Displays all of a vehicle's characteristics. This function is used to update the data files of each vehicle. Optionally, vehicles can be organized in groups in order to provide visual data on multiple vehicles performing the same task (i.e., Highway Security vehicles).

2.4.1. Specific functions for Winter Highway Administration.

In addition to the data obtained from the functions common to the whole fleet, we can obtain the air temperature and humidity, dosage and width of the melting agents that have been spread and the working location of snow ploughs. Data on the extension of melting agents and on the condition of snow ploughs is obtained directly from their controls without the aid of intermediate sensors which could distort or falsify the information.

The program can display on-screen the different preventative and curative treatments that have been carried out during the selected period and identify them by means of color-coding. The situations displayed are:

Preventive: moving vehicle + extension of melting agents activated + snow ploughs deactivated.
Curative: moving vehicle + extension of melting agents activated + snow ploughs activated
Snow-removal: moving vehicle + extension of melting agents deactivated + snow ploughs activated.

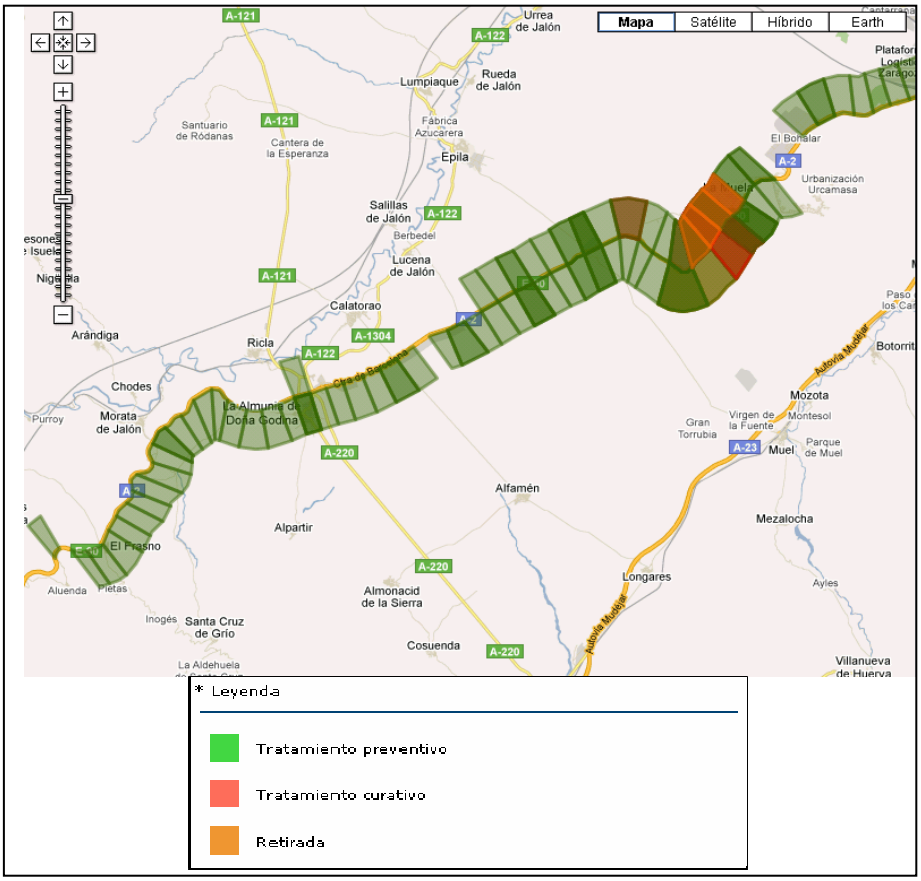
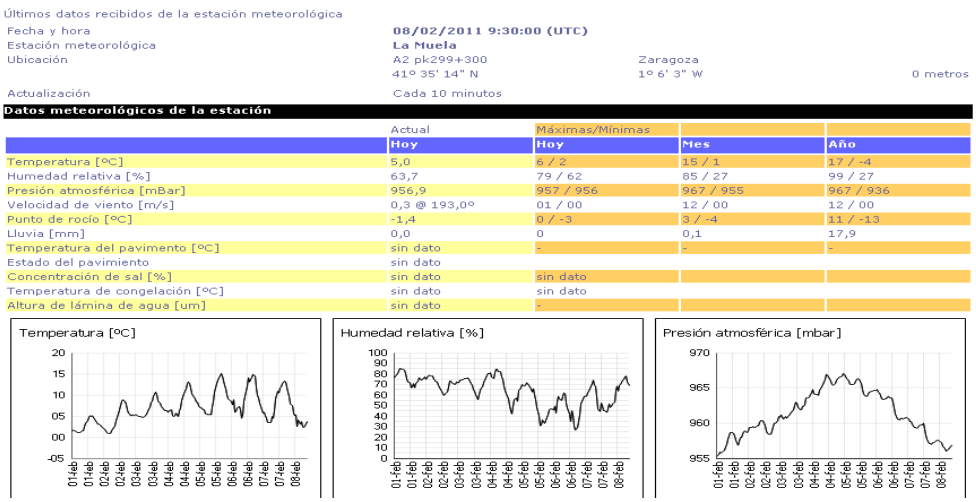


Figure 11 – Winter Highway Administration treatment display

2.5. Weather Station Management

Allows for quick access to information provided by a set of weather stations that send their measurements to a centralized system where this data is available to all users.

The maximum, minimum and average air and road surface temperature, wind speed and direction, relative humidity, dew-point and atmospheric pressure is displayed for each station.



Últimos datos recibidos de la estación meteorológica

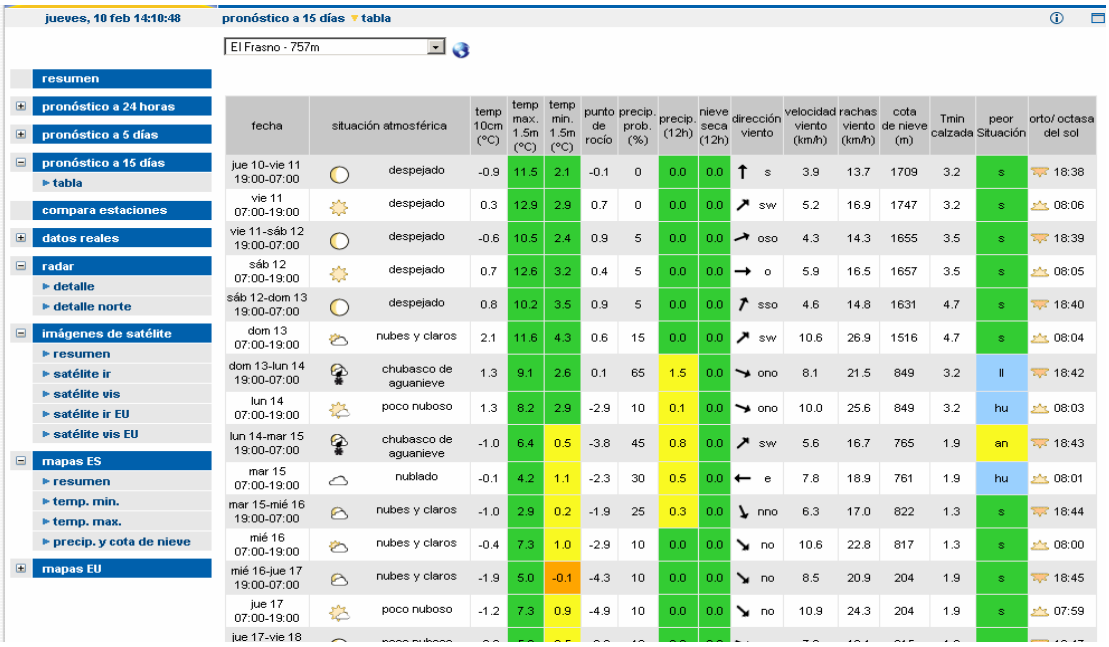
Fecha y hora	08/02/2011 9:30:00 (UTC)			
Estación meteorológica	La Muela			
Ubicación	A2 pk299+300	Zaragoza		
	41º 35' 14" N	1º 6' 3" W		0 metros
Actualización	Cada 10 minutos			

Datos meteorológicos de la estación

	Actual	Máximas/Mínimas		
	Hoy	Hoy	Mes	Año
Temperatura [ºC]	5,0	6 / 2	15 / 1	17 / -4
Humedad relativa [%]	63,7	79 / 62	85 / 27	99 / 27
Presión atmosférica [mBar]	956,9	957 / 956	967 / 955	967 / 936
Velocidad de viento [m/s]	0,3 @ 193,0º	01 / 00	12 / 00	12 / 00
Punto de rocío [ºC]	-1,4	0 / -3	3 / -4	11 / -13
Lluvia [mm]	0,0	0	0,1	17,9
Temperatura del pavimento [ºC]	sin dato	-	-	-
Estado del pavimiento	sin dato			
Concentración de sal [%]	sin dato	sin dato		
Temperatura de congelación [ºC]	sin dato	sin dato		
Altura de lámina de agua [um]	sin dato	-		

Figure 12 – Weather Station data.

This data is handled by a private company dedicated to weather forecasting studies which is hired by the concessionaire. They provide us with daily weather reports and online access to forecasts for the highway section of various periods (24 hours, 5 days and 15 days). This additional information, along with the official data from the State Weather Agency (AEMAT), allows us to schedule winter highway administration activities with greater precision, generating the corresponding work orders in the module "Works Management" and recording them in the module "Incident Management".



fecha	situación atmosférica	temp 10cm (°C)	temp max. 1.5m (°C)	temp min. 1.5m (°C)	punto de rocío	precip. prob. (%)	precip. (12h)	nieve seca (12h)	dirección viento	velocidad viento (km/h)	rachas viento (km/h)	cota de nieve (m)	Tmin calzada	peor Situación	orto/ octasa del sol
jue 10-vie 11 19:00-07:00	despejado	-0.9	11.5	2.1	-0.1	0	0.0	0.0	s	3.9	13.7	1709	3.2	s	18:38
vie 11 07:00-19:00	despejado	0.3	12.9	2.9	0.7	0	0.0	0.0	sw	5.2	16.9	1747	3.2	s	08:06
vie 11-sáb 12 19:00-07:00	despejado	-0.6	10.5	2.4	0.9	5	0.0	0.0	oso	4.3	14.3	1655	3.5	s	18:39
sáb 12 07:00-19:00	despejado	0.7	12.6	3.2	0.4	5	0.0	0.0	o	5.9	16.5	1657	3.5	s	08:05
sáb 12-dom 13 19:00-07:00	despejado	0.8	10.2	3.5	0.9	5	0.0	0.0	sso	4.6	14.8	1631	4.7	s	18:40
dom 13 07:00-19:00	nubes y claros	2.1	11.6	4.3	0.6	15	0.0	0.0	sw	10.6	26.9	1516	4.7	s	08:04
dom 13-lun 14 19:00-07:00	chubasco de aguanieve	1.3	9.1	2.6	0.1	65	1.5	0.0	ono	8.1	21.5	849	3.2	ll	18:42
lun 14 07:00-19:00	poco nuboso	1.3	8.2	2.9	-2.9	10	0.1	0.0	ono	10.0	25.6	849	3.2	hu	08:03
lun 14-mar 15 19:00-07:00	chubasco de aguanieve	-1.0	6.4	0.5	-3.8	45	0.8	0.0	sw	5.6	16.7	765	1.9	an	18:43
mar 15 07:00-19:00	nublado	-0.1	4.2	1.1	-2.3	30	0.5	0.0	e	7.8	18.9	761	1.9	hu	08:01
mar 15-mié 16 19:00-07:00	nubes y claros	-1.0	2.9	0.2	-1.9	25	0.3	0.0	nno	6.3	17.0	822	1.3	s	18:44
mié 16 07:00-19:00	nubes y claros	-0.4	7.3	1.0	-2.9	10	0.0	0.0	no	10.6	22.8	817	1.3	s	08:00
mié 16-jue 17 19:00-07:00	nubes y claros	-1.9	5.0	-0.1	-4.3	10	0.0	0.0	no	8.5	20.9	204	1.9	s	18:45
jue 17 07:00-19:00	poco nuboso	-1.2	7.3	0.9	-4.9	10	0.0	0.0	no	10.9	24.3	204	1.9	s	07:59
jue 17-vie 18															

Figure 13 – 15 day weather forecast

2.6. Exploitation Management: SIGCAR.

The Exploitation Management module, SIGCAR, is for creating administrative reports corresponding to work authorizations, equity responsibilities, sanction reports, special transport permits, etc.

It incorporates all phases of the process, from data collection up to the completion of the reports, including tax, deposit and levy collection management, responses to allegations and additional data requirements when necessary.

The work process is based on a well-defined and structured administrative procedure which sets out the actions to be performed, models and/or templates to be used, administrative deadlines, those responsible for the processes and the conditions to be established for each of the reports issued.

The advantages that this module provide are:
Clearly defined procedures, participating entities and phases.
Uniform reports, by applying current models and templates.
Management of the deadlines permitted for the procedure in order to avoid expiration problems.
Incoming written reports are saved in the same file as the resolution, in order to have a historical report available for future consultations.

3. QUALITY AND STATE OF SERVICE INDICATORS

The service level of the key contract AO-Z-26 is evaluated for degree of compliance with the Quality and State of Service Indicators. PPTP and PCAP consider 41 indicators which cover the following areas: road surfaces, banks, area around the road, bridges, winter highway administration, highway safety, road markings, signals and vertical signs, contention elements, drainage, lighting, tunnels, accident and incident attention, patrolling, lane occupation and service level.

Each indicator has a defined method and frequency of measurement, minimum accepted values, and maximum time permitted to perform necessary corrections when they are found to be below the required levels.

Additionally, each of them indicates when penalties have been incurred, values for which upward or downward corrections are to be applied to the monthly rate and the percentage to be applied in each case.

Adequate control of the indicators is fundamental to the proper functioning of the concession, both for maintaining the quality, user comfort and service levels required by the bid specifications and for the important repercussions it has in the economic results of the contract.

INDICASER, the application used for managing indicators, records the detection date, location, indicator affected and correction date, including pictures of the incident before and after repair.

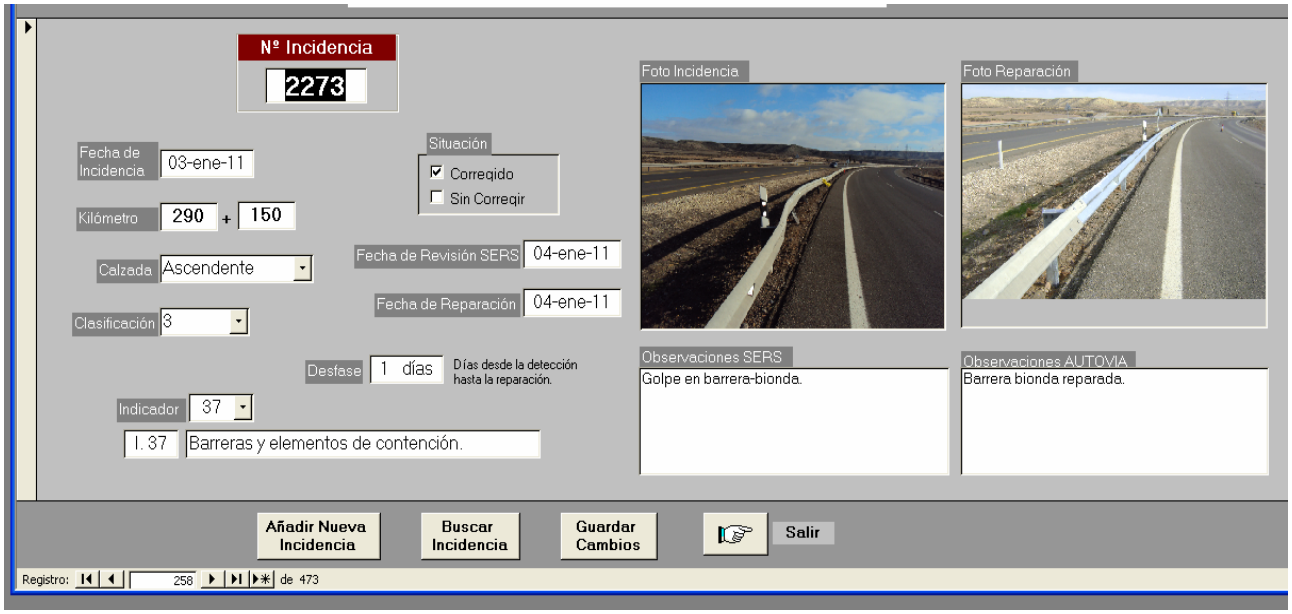


Figure 14 – Indicator state file

Incidents related with an indicator are opened from the advisories recorded in the module "Incident and Advisory Management" and from the programmed inspection results in the module "Works and Operating Costs Management". Likewise, each indicator related incident generates a corrective work order in the module "Works and Operating Costs Management".

This application can provide reports based on type of indicator, dates, resolved incidents, unresolved incidents, resolution deadlines, ...

In order to plan large road surface replacement activities, the road surface management application ICARO has been contracted from a private company. Using the geometrical characteristics of the highway, the surface of each highway section and an analysis of periodical road surface inspection results (CRT, MACROTEXTURE, IRI, FISSURING, ...) as a starting point, and after determining the desired quality level to be maintained, the program can provide action plans which meet the technical requirements of the concessionaire. These action requirements, based on the evolution of data collected during auscultation, allow us to plan and budget for works to be performed, thereby optimizing the useful life of road surfaces both economically and operationally.

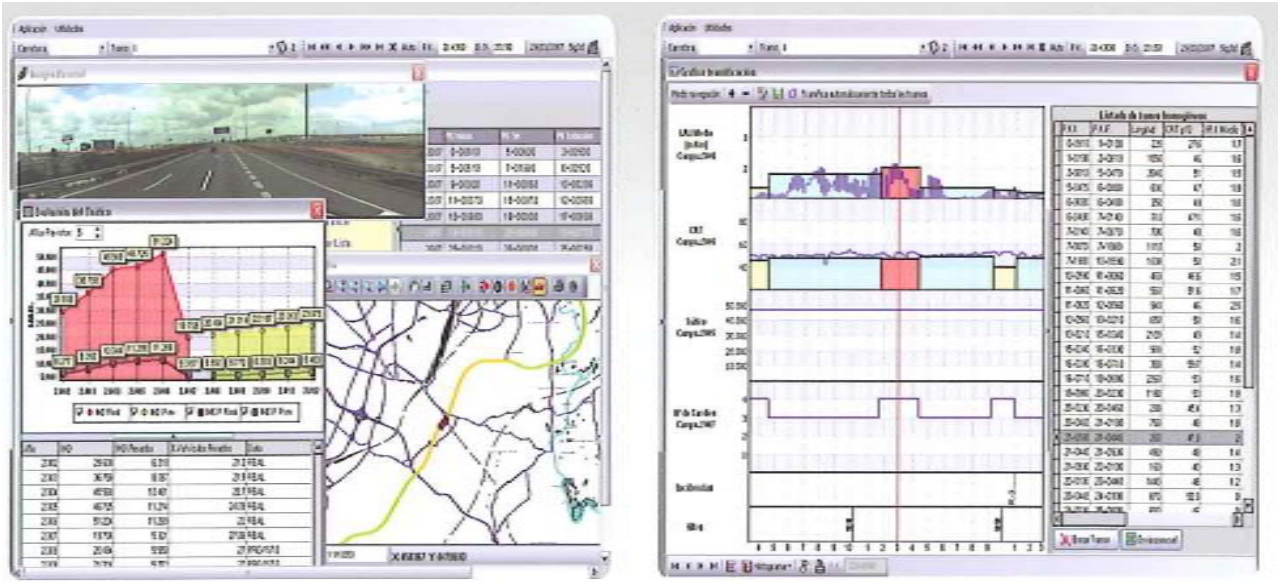


Figure 15 – Road Surface Management System

4. CONCLUSIONS

4.1. Traffic.

The traffic data management program is fundamental to the development of the contract due to the fact that the government administration makes monthly payments to the concessionaire based on this data. Immediate detection of errors or faults in the counting systems is very important as the loss of traffic data means a reduction in monthly turnover.

4.2. Inventory Management (SIMC4).

A proper inventory is fundamental to the development of conservation and exploitation work. By having all elements of the infrastructure perfectly defined and up to date, acting together with the module "Works and Operating Costs Management", the inspections set out in the indicators can be planned and the equipment ordered to carry them out can be properly evaluated in order to finish them properly and on time and thus avoid penalties. Another of its practical uses is saving technician's travel time when performing routine consultations on the highway section since videos are available for this. It also allows us to take advantage of bulk purchase discounts on materials since we are aware of each element quantitatively and, through MAXIMO, their consumption.

4.3. Incident and Advisory Management (ECO).

By means of this module, we obtain transparency of the concessionaire's incident management, with a large quantity of information available to the government administration so they can carry out any reviews they deem necessary. It also gives the company the ability to justify its actions whenever necessary, since it compiles all the steps taken to deal with a given incident. It allows for later review of incident action developments in order to evaluate them.

4.4. Works and Operating Costs Management", (MAXIMO).

Provides a planning and control system for work performed. The concessionaire knows which activity they spend more money on, how much material is consumed, which highway sections have higher maintenance budgets and, together with the indicator data, they can study variations in work equipment and in task frequency, increase specific operations on certain highway sections, etc.
As an example, as a result of applying the roadside and rest area cleaning indicator, several areas were discovered where rubbish accumulated faster than on the rest of the highway section and the frequency of cleaning, however, was the same for all areas of the highway. Once this was detected, a second cleaning team was formed to perform occasional clean-ups at those points with larger build ups of rubbish. This led to less time between cleaning at those points and compliance with the indicator, thus avoiding penalizations.

4.5. Fleet Management.

There are several benefits that this system provides:
Proof of compliance with the bid specifications related to security rounds in order to avoid government administration penalties and paying for patrimonial liability proceedings which the government may pass to the concessionaire if incompliance with the minimum number or rounds set forth in the bid specifications is demonstrated..
Proof of compliance with winter highway administration operating plans. This is a very important aspect for avoiding economic sanctions and even the contract being rescinded.
Controlling company personnel (travel times, locations, length of stops, etc). This allows for greater team productivity and optimized operating costs.
Preset routes for both security and snow removal teams in order to avoid unnecessary displacements, save fuel and increase speed and effectiveness of said operations.

4.6. Weather Station Management

This module allows for optimization of available resources when organizing winter highway administration activities. When snow advisories happen on weekends or holidays, when personnel costs are calculated as overtime, correct interpretation of the information received allows for accurate forecasting of the storm duration, intensity and the highway section affected and therefore the personnel and equipment needed to deal with the foreseen situation can be made available and unnecessary costs resulting from excess resource allocation avoided.
Additionally, the ability to have a 15 day weather forecast is resulting in improved work team organization as their work is not suddenly and unexpectedly affected by weather advisories. This results in a greater systemization of activities and allows incidents to be resolved within established timeframes and economic penalties to be avoided.

4.7. Exploitation Management (SIGCAR).

Provides uniformity to the processing of different administrative reports, avoids loss of documentation as it is integrated in a single database and facilitates the consultation of older files, thus avoiding wasting time looking for physical documents.

4.8. Quality and State of Service Indicators Management (INDICASER).

This program allows us to organize work teams to give priority to incidents with shorter resolution timeframes and get them completed before the deadline set out in the Quality and State of Service Indicators is up and therefore avoid economic penalties.

4.9. Road Surface Management (ICARO).

This road surface management application allows us to set up a preventive conservation strategy. This way, short term and limited cost actions are planned which comply at all times with the road surface indicators.
The advantages of using this program for planning are clear:
Penalties and downward adjustments are avoided and rebates can even be obtained by applying the indicators.
The investments needed for performing these actions are smaller than when a curative management model is applied. Periodicity is approximately 5-6 years, which makes them more uniform and also means they are provisioned for in the concessionaire's budgets.
In turn, having road surfaces in good condition for a longer time also influences other condition indicators such as those related with highway safety, thereby providing an intangible benefit to the user (safety, comfort, fewer incidents affecting vehicles, etc) as well as a tangible benefit by avoiding penalties related with these indicators.