



SINA

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Surveillance of road engineering structures



SINA S.p.A. has been working in major transport infrastructures engineering for more than half a century

SINA S.p.A. has been working in major transport infrastructures engineering for more than half a century with a particular focus on their planning, control, maintenance and management.

It boasts constant growth in both turnover and workforce and, thanks to its capacity to supply its clients with a highly-innovative global service, it holds a leadership position in the reference sector.

Membership of the **ASTM GROUP** – one of Italy's most important industrial groups - and the close integration with the motorway concession-holder members offer Sina extraordinary opportunities for the application and development of its own scientific and technical resources.

The growing social sensitivity towards aspects relating to the ageing of the structural works comprising the national road and rail heritage, in view of the ever greater quantities of circulating traffic, makes the adoption of objective, repeatable engineering methods and processes by which to control and assess the functional and structural condition of the works of art, increasingly important.

For more than thirty years now, **SINA S.p.A.** has had a specific Engineering Unit in place, specialised in the control and maintenance of major transport infrastructures and which permanently surveys works of art using measurement tools, including some highly technological developments, to map defects and allow for an assessment of the general state of deterioration of the structures examined. The Company can carry out inspections aimed at verifying the state of conservation of complex structures like bridges, viaducts and tunnels, as well as any subsequent finalisation of a specific plan of interventions aimed to returning the work as a whole to a suitable standard in terms of both performance and safety.

The activity aims to assure the infrastructure manager timely information, constant specialised technical support and all the consultancy necessary to draw up suitable maintenance plans.

All this is made possible thanks to the considerable professionalism and wealth of experience acquired in the field by the technicians used to carry out the checks, interpret and analyse the results and consequently propose interventions.



Works

Sina has always been constantly involved in the inspection, testing and controlling of major and minor structures present on the motorway network managed by the ASTM Group, which consists of more than **1,500 km of lanes** in the north-west of Italy.

The infrastructures under permanent surveillance number almost **2.700 works**, of which **1.810 are bridges** and/or viaducts stretching out for approximately 340 km and **are tunnels**, extending for more than 195 km, for a total of more than **145,000 structural elements**.



Inspections

The main aim of the inspections and controls is to record the condition of the works and highlight “potential failures” before they become “functional failures” and, therefore, to confirm the time when replacement is necessary, pre-defined on the basis of the conduct of the objects in question at failure. In process terms, the following are the main steps:

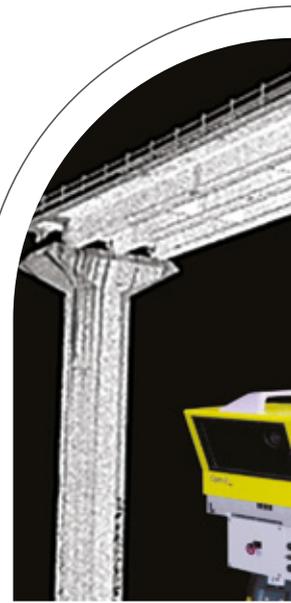
- Survey of the current condition (inspection);
- Interpretation of the damage evolution of with respect to previous surveys (reprocessing according to historic data and to the mathematical models);
- Assessment of the present deterioration level together to the “expected” deterioration and identification of the required maintenance interventions;
- Scheduling of the necessary maintenance works (BMS - Bridge Management System).

The experience in simultaneously running inspection campaigns over a large number of works and the need to achieve summary opinions of the whole, have led to the perfecting of procedures and methods governing the inspection, fundamentally adopting two inspection methods according to the concept of the “hierarchy of knowledge”:

- **The visual inspection** involves a detailed survey of the anomalies and their representation on graphical designs of the elements, by means of visual and/or instrumental observation and detailed quantification of each defect, with the integration of geometric and material tests;
- **The surveillance inspection** involves an assessment of the evolution of the main anomalies recorded in the previous visual inspection, through a direct comparison of the two subsequent inspections.



“ Innovation as a value „



Inspection involves some conceptual phases on which the works management database is based.

- 1 Work typing**, which involves the “**engineering**” of the data through the recognition of:
 - assessment and breakdown of the work into structural units;
 - breakdown into recurring – archetype elements;
 - association of a deterioration model (reference values) for each element type and acknowledgement of the failure causes (anomalies);
 - breakdown of the structure into elements (list of elements).
- 2 Definition of deterioration:** each type of element is associated with a list of anomalies according to various parameters (material, construction type and manufacture, failure methods and inspection objective). When modelling and carrying out the structural analysis of the work, each type element is therefore associated with a list of anomalies.
- 3 Inspection register:** as part of a permanent surveillance approach, a correct and careful recording of inspection activities and related warnings , performed over time on each individual work, becomes essential and must be complete with all relevant and useful information about each individual activities carried out.
- 4 Post-processing** of the inspection to be carried out by means of standardised, validated methods on several levels of detail.
- 5 Analysis and assessment** of the works network systems: this phase entails the development of Performance Indicators and Index Values, which can determine scales of priority of maintenance works. The idea is to start out from the analysis of the individual structural elements and, therefore, use subsequent aggregations to assess the condition of the work, proposing maintenance intervention scenarios throughout the residual operative life.





“ Continuous surveillance to preserve value ”

Supplementary investigations

The investigations have the main aim of documenting the level of knowledge of the work in order to prepare the calculation model for assessing capacity. These require the collection and critical examination of dimensions, characteristics and conditions of materials and structural elements, with the aim of identifying the structural organism with its construction details, material properties and presence and causes of any unsatisfactory behaviour. The main in-depth tests that can be carried out on the structures include:

- ◆ **destructive tests, including:** cores and micro cores with compression stress tests to determine the strength of the concrete;
- ◆ **non destructive tests, including:** sclerometric method, ultrasound methods, Windsor method, pull-out tests, welding checks and video endoscopy, tests to determine carbonation depth, chemical analyses, load tests measuring strains and displacements, dynamic characterisation tests to define static behaviour and the strength of bending structural elements.

The tests sector can be supplemented, if further analysis is required, with other traditional or innovative investigations, such as: the GPR (Ground Penetrating Radar), infra-red thermography, laser scanning including drones, or even the development of permanent structural monitoring systems.



Software

During the course of its activities, SINA has finalised and now offers various different software applications aimed at assuring a computerised management system of road networks, including engineering structures.

The applications have been developed with the aim of supplying managers with user-friendly tools offering a simple, intuitive graphical interface and therefore such as to allow an immediate access to all needed and requested information.

- **"SCART" centralised, automated territorial survey system.**

This application tool rationalises resources and time in the planning and execution of in-situ field data collection activities. The application allows the teams of technicians, equipped with suitable hardware (PC, tablet and/or PDAs with GPS and cameras) to collect data and information with simultaneous georeferencing and the automatic acquisition of descriptive photographic documents.

- **"SIOS" works inspection system.**

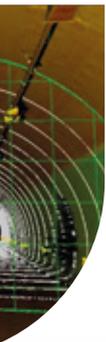
The application allows a complete management of data resulting from the inspections of any type of work, for its processing and the determination of the condition, intended as an Index Value of the individual elements or of an assembly of elements or indeed of the work as a whole. The system used to assess structural deterioration is highly detailed and can perform digital processing (calculation of an "Index Value"), developing detailed graphics for each element of each work.

- **B&TMS - Bridge and Tunnel Management System.**

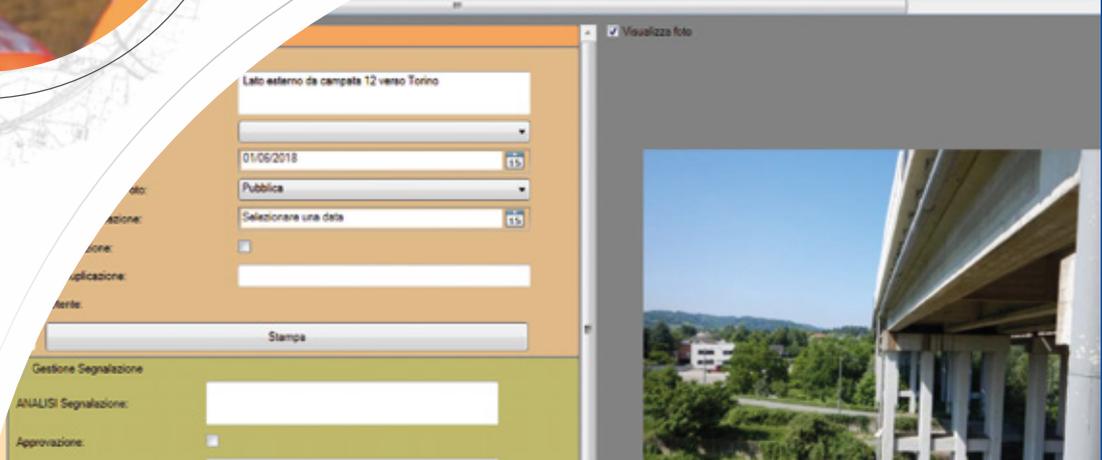
The application provides a decision-making support system regarding scheduled maintenance on bridges and tunnels. Starting out from the information obtained through work monitoring/surveillance, it can identify the best possible maintenance scenarios and optimise work on the relevant structures.

- **TuView, Tunnel-Inspector and Tunnel-Info.**

The software applications created and developed on the basis of the Company's know-how allow the computerised management of road/rail tunnels through a series of functions on the basis of specific mobile laser scanning technology (TSS Tunnel Scanner System), combined with the results of visual inspections performed at set frequencies over time. This makes it possible to estimate and catalogue deterioration by severity and extension, monitoring its evolution and preparing organic plans of action that combine economic optimisation with the expected level of service and taking into account any minimal interference with operation.



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Services

CLIENT

SERVICE DESCRIPTION

ANAS SPA	Road asset inventory and inspection of the major engineering structures along road network of the Basilicata Regional Authority
A10 - ADF AUTOSTRADA DEI FIORI	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
A12 - SALT SOCIETÀ AUTOSTRADA LIGURE TOSCANA	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
A15 - AUTOCISA AUTOCAMIONALE DELLA CISA	Motorway tunnel inspection and monitoring services
A21 - SATAP AUTOSTRADA TORINO-PIACENZA	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
A21 AUTOVIA PADANA AUTOSTRADA PIACENZA-BRESCIA	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
A2A SPA	Monitoring of the Morbegno hydroelectric plant culvert
A33 - AT-CN AUTOSTRADA ASTI-CUNEO	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
A4 - SATAP AUTOSTRADA TORINO-MILANO	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
A5 - SAV SOCIETÀ AUTOSTRADA VALDOSTANA	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
ANAS SPA	Road asset inventory and inspection of the major engineering structures along road network of the Lombardy Regional Authority
ARGENTEA - A52 BRE.BE.MI AUTOPSTRADA BRESCIA-BERGAMO-MILANO	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
ATM SPA	Laser and thermographic scanning of the underground M2 Line in Milan
AUREA - A53 TEEM TANGENZIALE EST ESTERNA MILANO	Multi-year framework agreement for the continuous surveillance of bridges and other road engineering structures
IMPERIA MUNICIPALITY	In-depth inspection of the viaduct over the Impero River
ESCOTA - GRUPPO VINCI AUTOROUTES	Visual and instrumental inspection of the tunnels along the A8 Menton-Mandelieu-La Napoule Motorway
FERROVIE NORD SPA	Laser scanning of the tunnels along the Regional "Milan Network" railway
GEF - TRAFORO AUTOSTRADALE DEL FREJUS	Monitoring of the motorway tunnel surface condition
ITALFERR SPA	Inspection and laboratory tests of the Miglionico tunnel located in the new Ferrandina-Matera railway line
ROME MUNICIPALITY	Surveillance and monitoring of the bridges and other road engineering structures located along the "Grande Viabilità" road network (Municipalities from I to XV)
SITRASB - SOCIETÀ ITALIANA TRAFORO DEL GRAN SAN BERNARDO	Visual and instrumental inspection of the network viaducts
VI.ABILITÀ SPA	Visual and instrumental inspection of 21 bridges located along road network in the south area of Vicenza Province



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