



Ortisei Meeting of 7th December 2001

SELF-SERVICE DEICING SALT FACILITIES

SPEED - PRECISION - EFFECTIVENESS

Stefano Murazio*
Geom. Andrea Marin**



The table of speakers at the Ortisei meeting from left to right: Ing. Romano Foschi, Pavimental consultant, Ing. Stefano Murazio, former General Manager of Autostrade, Maria Pia Cerciello, Manager of ANAS Unit, Andrea Marin, CEO of Agristrade, Ing. Noris Strapazzon, Technical Director of Agristrade

In recent years, the visual and environmental impact brought about by the installation of vertical storage facilities for chlorides are being given more focus by roadway authorities. The problem has been given an intelligent solution with the design and development of large-capacity modular storage facilities with a maximum height of 10-11 m which offer a reduced environmental impact.



The many advantages of these facilities have been widely discussed in past meetings and are receiving positive feedback from industry members on a European level, not only because of their environmental friendliness, but especially due to the advanced technologies adopted for their design and development, which enable heavier work requirements to be met with improved results. The Società Agristrade has recently received an important order to supply the Trento province with two latest-generation storage facilities.

Not all sites are suitable for installation of these facilities, however, both because of the need to use systems with only medium storage capacities and because space restrictions do not permit it. For these reasons, systems were studied and developed that would ensure a correct balance between the quantity stored and the vertical and horizontal space occupied.



Project data

To achieve these goals without having to forgo the universally recognised advantages of salt spreading, the project provided for cylindrical silos with a large diameter (8.57 m) and with a 45° discharge cone. These rigorous project specifications also made it possible to obtain a quantity of 500 tonnes of ensilaged material, in turn enabling a reduction in the total height of the facility to 15.50 m. It should be noted that silos containing an equal quantity, with volumetric measurement of the discharged material, can reach a height of 25 metres! Using high precision weighing systems integrated with sophisticated, yet user-friendly computer technology has made it possible to transform simple storage facilities into automatic self-service salt dispensers.

The Direzione III° Tronco di Bologna of the Società Autostrade SpA has adopted these innovative systems, which are installed and functioning at the Maintenance Stations of Casalecchio di Reno, Bologna-San Lazzaro and Forlì.

Materials and technologies

The silo

The highly aggressive physical-chemical characteristics of saline deicers commonly used for winter road maintenance are well known. To guarantee the maximum standards of quality and long life, all parts in direct contact with the salt (cone, cylinder, dome) are built in vitrified sheet steel (internally and externally), whose long life and resistance to chemical agents has been widely documented over several decades with structures completely free of corrosion.

All other parts (loading bearing structure, filling and breather pipes, stairs, galleries, gangways, etc.) while not in direct contact with the salt, were hot-galvanised (immersion in zinc bath at over 600°C) to provide a minimum thickness of 100 microns.

Among the most important safety features that have resulted from the manufacturer's 30+ years' experience are:

- ◆ The dome of the silo has a central anti-implosion valve with counterweights and three peripheral valves with magnetic seal; these valves intervene automatically to compensate for or reduce sudden depressions inside the silo from possible (however improbable) "bridge" collapses caused by moist salt or salt that does not meet ensilage specifications;
- ◆ The extremity of the cone features airtight maintenance manholes to allow obstructions to be cleared mechanically even when the discharge gate is closed;
- ◆ The silo's cone is installed with three automatic eccentric vibrators to facilitate the downflow of salt;
- ◆ A pressure accumulator automatically and instantly stops the salt discharge in case of emergency or blackout.
- ◆ A dehumidification system is included so that the reintegration of the compensating air inside the silo during the discharges of salt takes place with almost completely dry air.

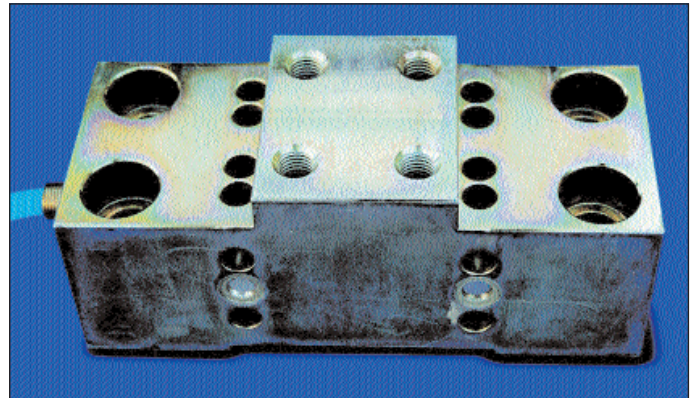
The weighing system

The facility's weighing system is composed of six double bending load cells that can guarantee the highest standards of reliability and precision (combined maximum error 0.75%).

These cells are placed on plates for the stiffening of the foundation plinth and anchored to the columns forming the load bearing structure of the silo. The technological characteristics of the project made it necessary to strengthen and stiffen the load bearing structure for struc-

tural and stabilising purposes and also to guarantee a load that was exactly perpendicular on the cells.

Other much less expensive weighing systems were excluded (e.g., strain gauges currently on the market) that could not guarantee pre-



Load cell for precision weighing

cise management of the discharges, because they were particularly sensitive to thermal variations and had inadequate response times. The continuous, precise and instantaneous monitoring of the quantities stored, loaded and discharged also results in advanced statistical management.

To further guarantee operation, a system of strong brackets applied to the lower part of the load bearing columns allows the silo to be lifted even when fully loaded by means of hydraulic systems in order to perform replacement of a malfunctioning weighing cell (an unlikely event given the load cell's efficiency).

The above features verify the precision of the project and the attention devoted to the resolution of problems in the highly unlikely event they may arise during the facility's operation.

The salt discharge system

The facility's weighing system, thanks to the precision and the ability to read the variations of the loads on demand, has contributed to a highly simplified system of salt discharge.

A single discharge gate can automatically regulate the speed and quantity of the flow.

The facility's management software processes the data from the load cells by automatically regulating the section and the amount of time the gate is opened according to the quantities of salt requested by the operator.

This signifies very important operating advantages such as:

- ◆ The use of the gravity discharge system means that only one operator is needed to perform automatic loading operations of the spreader in a very short period of time (approx. 3 minutes for a spreader of 10 cu m versus the 15-20 minutes necessary for other mechanical systems currently in use).
- ◆ This feature is guaranteed also in emergency or adverse weather conditions that may occur during winter roadway deicing operations (power failure, etc.). The result is a high quality road maintenance service given the short span of time between the beginning of the emergency and the salt spreading operations;
- ◆ Very limited consumption of electricity; to move the discharge gate with a maximum travel of 500 mm, only 1.5 kW are necessary for the opening, the start of the discharge and the closing;
- ◆ Therefore, the occasional movement of simple sliding parts and at reduced applied force leads to a minimum wear and conse quen-

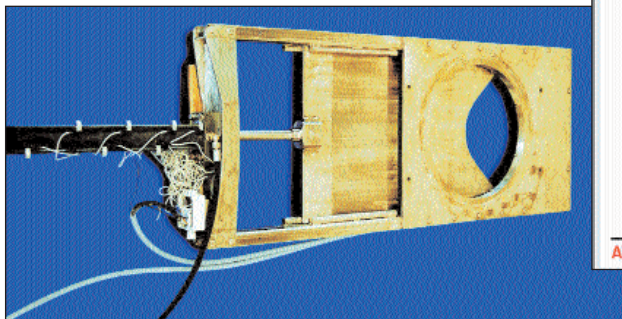


tially extreme reliability and extended life, with practically no maintenance necessary;

- ◆ The precision of the weighing system lends itself perfectly to future integration of the facility with systems for the automated preparation of saline solutions in the percentages required.

The discharge system is composed of the following:

- ◆ An airtight discharge gate built in 100% AISI 316 stainless steel which guarantees, in addition to the correct downflow of the salt, the sealing off of the silo with an AISI 316 L stainless steel ring which adheres uniformly to the blade by means of a rubber piece creating pressure;
- ◆ The airtight gate fits a special piston installed with seven capacitive proximity switches which are adjustable according to the amount of the discharges required and the particle size of the salt;
- ◆ A hydraulic unit for movement of the piston including pressure accumulator operating by liquid nitrogen re-loading for immediate emergency closing of the airtight gate in case of sudden power failure or emergency stop activated by the operator;
- ◆ It also features a double-acting manual pump to allow the opening and closing of the airtight gate and therefore the discharge of the salt in any emergency condition (power failure, etc.);
- ◆ A manually commanded maintenance gate built in 100% AISI 316 L stainless steel located above the airtight gate.



Airtight gate for variable automatic measuring in test phase

Its purpose is to isolate the devices lying underneath from the salt and to permit maintenance or, in rare cases, the disassembly of the devices with the silo full.

System of loading and distribution of the salt into the silo

Because of the large diameter of the silo, resorting to traditional loading systems with central loading pipe on top of the dome would have brought about a heavy loss in the volume usable by the facility, caused by the natural cone formed by the depositing of the rock salt with horizontal angle varying from 30° to 35°.

As a result, a special system would have to be used to enable uniform distribution of the material on the extensive internal surface in order to optimise filling operations. A patented rotating loading system inside the silo, automatically activated when the airtight closing unit of the loading and breather pipe are opened, suits this purpose perfectly.

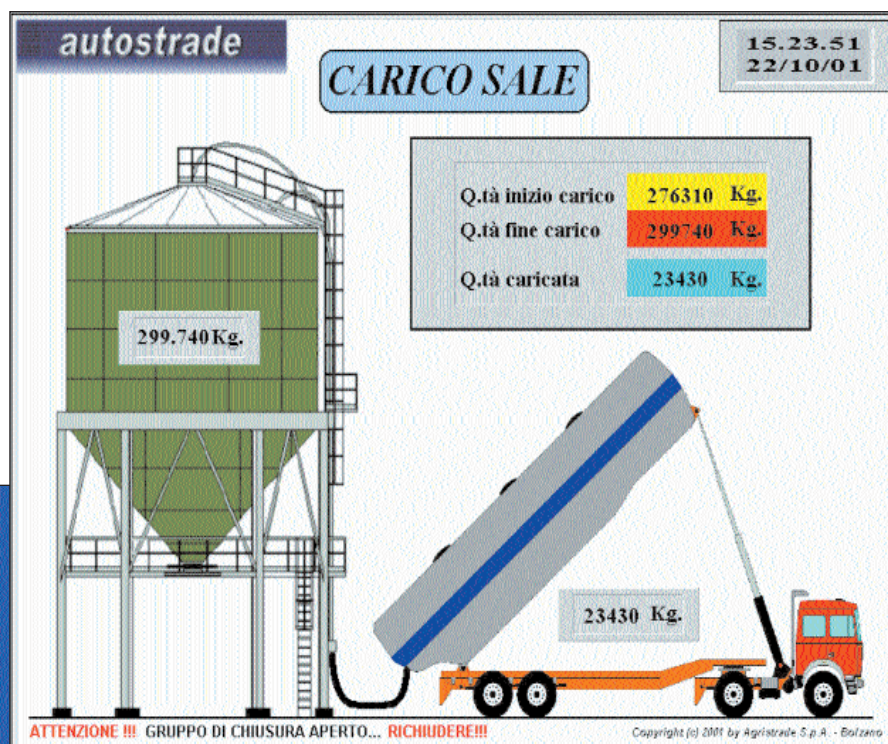
Study of the loading system also took into account the importance of reducing friction so as to prevent the salt from forming hazardous dust and to best conserve the initial particle size.

Computerised control panel

The computerised control panel is housed in the control cabin adjacent to the facility to assure a perfect visibility of the discharge when salt is being dispensed.

The panel is composed of a large lectern-type cabinet and is marked with easy-to-read silk-screened synoptic plates.

An industrial computer with touch screen monitor, interfaced with



a powerful control processor, oversees all operational and control phases of the facility as well as the management of the logs and the graphics.



Detail of control panel



Winter Roadway Safety

Operating and management software

Researched and developed to suit the specific operating requirements of Autostrade, the software allow access to the facility only by personnel in possession of ID code. Specifically, these personnel have access to:

Operator menu

Operators, whether directly employed by Autostrade or by outside companies, may have access only to the salt discharge functions, which are fully automatic, highly simplified processes.

Through constant guidance by a system of easily comprehensible messages and graphics, even personnel without prior training will be able to discharge the required quantities of salt.

The first page displayed to the operator contains:

- ◆ A large key that asks for insertion of the operator code;



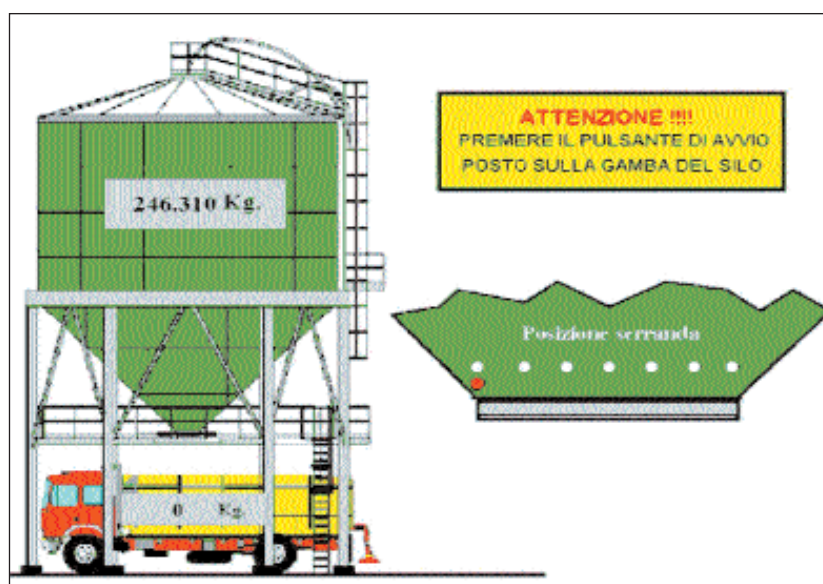
- ◆ A window indicating the weight of the salt stored in the silo, which is continuously monitored by the load cells;
- ◆ A window indicating the status of the facility and any malfunctions thanks to the constant self-diagnosis of the main safety devices.

By inserting the ID code on the specially designed keyboard, the operator accesses the next page, which gives the quantities of salt that can be discharged, starting with a minimum of 500 kg and reaching a maximum of 11,500 kg (500 kg, 1000 kg, 1500 kg, 11,500 kg). Pressing the key indicating the requested quantity eliminates the need for the operator to insert the request, making the procedure simplified and error-free. With the key "Other Quantities" the operator can select quantities different from pre-set amounts (for example, 9,370 kg). These quantities are limited to a maximum of 12,000 kg to avoid erroneous requests for higher quantities that can not fit in the spreaders. Once the quantity requested is confirmed, a message asks the operator to proceed with the start-up of the automatic

discharge cycle by pressing the flashing button at the foot of the silo. After pressing the button, the operator can enter his vehicle and wait for the pressure accumulator to load (approx. 30 seconds), a necessary step before discharge is activated. Signal lights and audible alarms indicate that the facility is ready to perform discharge.

When the working pressure is reached, the discharge gate is opened automatically in the position suitable for the quantity of salt requested. At this point, the operator can bring the vehicle forward and check by means of a mirror installed on the silo the uniform distribution of the salt inside the spreader, all while remaining in the vehicle.

A remote control device integrated into the system allows the operator to stop and resume filling as necessary directly from the cab of the vehicle. When filling is terminated, an audible alarm signals to the operator that the discharge has been performed correctly and the printer in the control cabinet prints out the salt discharge report. Any malfunctions (salt discharge interruption due to emergency stop or remote control command, power cut-off, etc.) appear on the report and are displayed on the monitor with instructions on how to resolve them.





Menu for facility manager

The facility manager is permitted access to perform higher-level statistical and operational control management procedures.

By entering his personal code, the manager may access a special menu which includes the following:

Change in operator code

This function allows the manager to modify the 15 ID codes of the operators



Menù riservato al responsabile dell'impianto

rators to meet new requirements (change in personnel, outside companies, etc.)

Counters reading

This displays the total quantities of salt discharged by each of the 15 authorised operators. Quantities are stored into memory starting from the date of the last reset.

Counters reset

Enables reset of all counters and asks for printout of the counters prior to reset.

Silo filling status

Displays the silo diagram with graphics and numerical display of the quantities stored and indication of a supply below acceptable levels.

The "reserve" threshold can be set according to specific requirements. When the quantities of salt in the silo descend below this level, an alarm sounds automatically on the first page of the monitor, on every discharge report and on the silo diagram mentioned above to warn operators and the facility manager that new supplies of salt are needed promptly.

Print-out management

This function enables access to a sub-menu permitting:

Counters print-out

Printout of the counters of the quantities of discharged salt from each of the 15 authorised operators starting from the date of the last reset.

Print-out of most recent discharges

Printout of the most recent discharges (max. 160) in chronological order starting from the last one.

Statement print-out

This function enables access to another sub-menu, "Data extrac

tion" which allows a full statistical control of all salt discharge operations performed by the facility.

The manager may select by pressing on a screen keyboard the period concerned and for which operator the data is to be selected.

The monitor then displays a table giving the date, time, operator, quantity, the outcome of the discharge (normal or with malfunctions, in which case the malfunctions are clearly indicated) for each automatic discharge procedure.

A "manual discharge" key gives information (similar to the above) on all manual discharge operations performed by the facility.

Rapporto prelievi dal: 01/07/01 Ore: 00:00 al: 11/09/01 Ore: 23:59 Operatori: 1-15 (seleziona) Data di stampa: 11/09/01

Data	Ora	Op.	Quantità	Concl. Precl.	Data	Ora	Op.	Quantità	Concl. Precl.	Data	Ora	Op.	Quantità	Concl. Precl.
02/07/01	10:51	7	01.800	Regolare	25/07/01	09:01	9	06.100	Regolare	04/08/01	15:31	8	01.500	Regolare
02/07/01	15:58	12	11.200	Regolare	25/07/01	09:28	8	05.800	Regolare	05/08/01	17:47	8	01.500	Regolare
02/07/01	16:27	12	06.800	Regolare	25/07/01	09:33	5	05.800	Regolare					
02/07/01	16:31	12	10.500	Regolare	25/07/01	09:35	5	05.600	Regolare					
02/07/01	16:34	9	06.100	Regolare	25/07/01	11:31	6	01.800	Regolare					
02/07/01	16:39	7	05.050	Regolare	25/07/01	11:35	1	01.100	Regolare					
02/07/01	16:42	7	05.500	Regolare	25/07/01	11:37	2	02.000	Regolare					
02/07/01	16:44	5	11.500	Regolare	25/07/01	11:40	4	02.190	Regolare					
02/07/01	16:46	5	04.220	Regolare	25/07/01	11:44	7	02.210	Regolare					
02/07/01	16:47	5	04.220	Regolare	25/07/01	11:45	0	01.100	Regolare					
02/07/01	16:51	1	01.700	Regolare	25/07/01	11:47	2	01.000	Int. Operat.					
02/07/01	17:07	2	02.500	Regolare	01/08/01	09:25	10	05.500	Regolare					
02/07/01	17:09	5	06.800	Regolare	01/08/01	09:30	14	05.700	Regolare					
02/07/01	17:11	11	09.000	Regolare	02/08/01	10:50	5	05.700	Regolare					
02/07/01	17:10	11	02.000	Regolare	02/08/01	10:54	0	01.450	Int. Operat.					
02/07/01	17:23	13	02.700	Regolare	02/08/01	11:27	2	01.100	Regolare					
02/07/01	17:35	2	00.000	Regolare	02/08/01	11:37	3	05.100	Int. Operat.					
03/07/01	09:07	2	11.500	Regolare	30/08/01	10:57	1	00.000	Int. Operat.					
03/07/01	09:15	3	11.110	Regolare	30/08/01	10:44	1	00.000	Int. Operat.					
06/07/01	17:16	11	01.000	Int. Operat.	30/08/01	10:49	1	01.800	Regolare					
06/07/01	15:11	4	02.100	Int. Operat.	30/08/01	10:53	2	01.100	Regolare					
06/07/01	08:40	1	07.100	Int. Operat.	30/08/01	11:20	5	05.500	Regolare					
10/07/01	08:58	1	06.000	Regolare	30/08/01	11:40	8	08.000	Int. Operat.					
17/07/01	16:30	1	00.000	Int. Operat.	30/08/01	12:37	2	06.300	Regolare					
17/07/01	16:41	1	01.100	Regolare	31/08/01	09:08	8	06.700	Regolare					
17/07/01	16:45	2	01.100	Int. Operat.	31/08/01	09:27	1	01.500	Regolare					
18/07/01	10:49	5	01.100	Regolare	31/08/01	09:35	5	01.500	Int. Operat.					
18/07/01	10:53	6	06.500	Int. Operat.	31/08/01	10:07	5	05.500	Regolare					
18/07/01	11:39	9	03.800	Regolare	04/09/01	11:35	5	05.000	Regolare					
18/07/01	11:45	1	01.500	Regolare	04/09/01	12:10	5	02.500	Int. Operat.					

Record Operat.: 62 Stampa Report Pagina Precedente Pagina Successiva Capotronco Pag. 1 di 1

All tables displayed on the monitor can be printed out on paper by a colour printer.

Silo loading report

Control of all silo loading operations.

The report is processed automatically at the time of each silo loading operation.

autostrade

Impianto: Casalecchio di Reno

RIEPILOGO PRELIEVI

Operatori: ☒ 1 ☒ 2 ☒ 3 ☒ 4 ☒ 5 ☒ 6 ☒ 7 ☒ 8 ☒ 9 ☒ 10 ☒ 11 ☒ 12 ☒ 13 ☒ 14 ☒ 15

Prelievi manuali: ☐ M

Dal giorno: 01/01/01 Dalle ore: 00.00

Al giorno: 15/09/01 Alle ore: 18.30

TOTALE QUANTITA' PRELEVATA: 215.640 Kg.

STAMPA USCITA

Data di stampa: 16/09/01 ore: 10.57.47

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A log is thus produced of filling operations specifying data on each operation including date, time, quantity at the start of the load, quantity at the end of the load and quantity loaded into the silo.



DATA	ORA	VALORE	VALORE	VALORE	DATA	ORA	VALORE	VALORE	VALORE	DATA	ORA	VALORE	VALORE	VALORE
04/09/2001	15:40	823.000	855.510	37.070	04/09/2001	15:40	823.000	855.510	37.070	04/09/2001	15:40	823.000	855.510	37.070
04/09/2001	16:12	829.500	865.060	35.560	04/09/2001	16:12	829.500	865.060	35.560	04/09/2001	16:12	829.500	865.060	35.560
04/09/2001	17:25	838.500	871.190	32.690	04/09/2001	17:25	838.500	871.190	32.690	04/09/2001	17:25	838.500	871.190	32.690
04/09/2001	18:33	845.500	884.300	38.800	04/09/2001	18:33	845.500	884.300	38.800	04/09/2001	18:33	845.500	884.300	38.800
04/09/2001	19:33	858.500	898.000	39.500	04/09/2001	19:33	858.500	898.000	39.500	04/09/2001	19:33	858.500	898.000	39.500
04/09/2001	20:27	864.500	908.390	43.890	04/09/2001	20:27	864.500	908.390	43.890	04/09/2001	20:27	864.500	908.390	43.890
04/09/2001	21:37	870.500	925.200	54.700	04/09/2001	21:37	870.500	925.200	54.700	04/09/2001	21:37	870.500	925.200	54.700
04/09/2001	22:15	878.500	936.500	58.000	04/09/2001	22:15	878.500	936.500	58.000	04/09/2001	22:15	878.500	936.500	58.000
04/09/2001	23:24	888.500	950.000	61.500	04/09/2001	23:24	888.500	950.000	61.500	04/09/2001	23:24	888.500	950.000	61.500
04/09/2001	00:59	892.500	954.000	61.500	04/09/2001	00:59	892.500	954.000	61.500	04/09/2001	00:59	892.500	954.000	61.500
04/09/2001	01:54	898.500	962.500	64.000	04/09/2001	01:54	898.500	962.500	64.000	04/09/2001	01:54	898.500	962.500	64.000

◆ Data saving

Data can be saved on a floppy disk from a disk driver on the control panel.

◆ Data restore

Allows the opposite function, i.e., for the data from the floppy to be saved on to the computer.

◆ Cell tests

Allows simple check of the correct operation of the load cells. A special page displays the facility's six loading cells, their operating status (normal or malfunctioning), the weight on each cell and the total weight.

◆ System shutdown

Performs standard shutdown of Windows with normal closing of all active procedures

◆ Date and time update

Allows standard updating of Windows of the system's date and time.



Conclusion

We have given a brief description of the facility's operation and the new technologies used for its design. We now conclude with a discussion of the important innovations being forged in the field and their important advantages.

◆ **Deicing salt self-service** facilities are managed with ease and precision because the dedicated software identifies all authorised users, whether they are employed by the Società Autostrade, or are outsourced contractors, etc.

The operating principle, due to its ease and efficiency, can be compared to that of the procedures used for an ATM machine (operator code and withdrawal) or self-service gas station (salt discharge).

The system was designed specifically to allow use not only by individual road maintenance administrations, but also by a range of users (consortiums of municipalities, various road maintenance administrations, etc.). Some European countries are seeing facilities being installed in strategic locations to allow common access.

◆ **Extremely rapid** salt dispensing performed fully automatically by a single operator directly from the vehicle cab (max. time 3 minutes, as a result eliminating downtime from manual discharge) means that many spreaders can be loaded with salt very rapidly.

This translates into effective, quick road maintenance with clear advantages to motorists and an improvement in general travel conditions.

◆ **Precision** of the quantities dispensed guaranteed by innovative and reliable weighing systems (load cells) enables the efficient control of all salt handling operations (loading into silo and discharge).

Specifically, it is a determining factor for determining the exact amount of each discharge in financial terms. In addition, identification of the user and the salt dispensed by the user provides an essential tool for ensuring effective management of the service, whether carried out by individual companies or consortiums.

◆ **Efficiency** of deicing operations is the logical outcome of these innovations.

It is a noted fact that guaranteeing successful winter road maintenance is strictly related to the speed with which the maintenance is carried out. The remote control of the three facilities set up by the Direzione di Tronco (motorway management authority) is an additional factor that contributes to effective service.

Obtaining information in real time on the operating status of the maintenance centres enables a more effective organisation of the operations.

Lastly, a remote assistance service is also offered by the Bolzano manufacturer.

This service, which offers shared access with other facilities, allows instant checking of the facility's operation, repair or maintenance for the elimination of operating malfunctions, technical support to the operator as well as a modification to the software should new requirements arise.

* Former Managing Director, Autostrade SpA and
**Geom. Andrea Marin, Chief Executive Officer, Agristrade SpA