



New techniques in winter road maintenance were illustrated during the annual Agristrade convention in Salzburg held in December 2002.

INNOVATIVE TECHNOLOGIES FOR WINTER SAFETY

Traffico & Mobilità

by Alessandro Melegari*

Built in 2001, the Snow Station of Citerna sits on the Apennine pass and is one of the most important and strategic Snow Stations for the management of the motorway section between the exits of Barberino and Roncobilaccio (approx. 20 km). The Snow Station's unique feature is a by-pass linking the two opposite carriageways, which permits the service vehicles to change their direction of travel without affecting motorway traffic.

Autostrade per L'Italia directly oversees 2,854.6 km of national motorway network. The territory is divided into nine "Direzioni di Tronco", whose management is coordinated by a head office with headquarters in Rome.

The Direzione IV Tronco based in Florence supervises a 207.5 km section of the Milan-Naples A1 motorway between the progressive km 210+100 near the Sasso Marconi exit and progressive km 417+600 adjacent to the Chiusi exit and along the entire A11 motorway between Florence-Pisa Nord, a stretch of 81.7 km connecting the capital of Tuscany with the Tyrrhenian Sea coast.



Characteristics of the section

The orography of the territory where the motorway cuts through has varying characteristics: from the Tuscany-Emilia Apennine pass (726 m above sea level) on the A1 the territory descends to the plains of Pistoia, Montecatini and Lucca along the A11, whereas continuing south to Rome the road cuts through the hills outside Florence to arrive at the border of Tuscany a few km after the Chiusi station.

The section carries heavy traffic, diversified in intensity and composition (see Table 1), and according to the altometric profile, weather conditions can vary greatly at different points. An analysis of the data makes evident how the section with a higher risk of snowfall, based on the co-existence of different parameters, is the Apennine tract between the Sasso Marconi exit and the Calenzano exit immediately prior to Florence. The reasons that make this section so critical (this part of the motorway was engineered in the late 1950s) lie in its geometry (48 curves with radius between 300-500 m and only 32 with a radius over 500 m) and in the climate. The Citerna pass, situated at the border between Tuscany and Emilia-Romagna at km 247 +000, reaches a height of 726 m above sea level and is subject to heavy snowfalls during winter.



Alessandro Melegari presents the technical report of the Citerna Snow Station

Aut.	Tratto	km totali	N.giorni T<0 ⁽⁶⁾	Quota max	Traffico/Giorno	I % long. max	N. gallerie x2 canne
A1	210+100 - Calenzano	68	56	726 s.l.m.	51.000 ⁽¹⁾	3,7%	24
A1	Calenzano - 417+600	139	32	324 s.l.m.	67.000 ⁽²⁾ 40.000 ⁽³⁾	3,9%	8
A11	Firenze - Pisa Nord	82	21	112 s.l.m.	60.000 ⁽⁴⁾ 38.000 ⁽⁵⁾	5,5%	1

Table 1 - (1) Average daily traffic along the Sasso Marconi-Calenzano section, (2) Average daily traffic along the Firenze Nord-Valdarno section, (3) Average daily traffic along the Valdarno-Chiusi section, (4) Average daily traffic along the Firenze-Montecatini section, (5) Average daily traffic along the Montecatini-Pisa Nord section, (6) Weather data referred to period 1-07-2002 - 30-6-2003



Deicers and their use

Deicers are primarily sodium chlorides, dry or humidified, and the 27% solution of calcium chloride, produced and purchased by the Società Solvay located in Livorno.

The humidified sodium chloride is utilised both for preventive treatment and for removing the sheet of snow. When low temperatures are present (below -5°C) or in the event of a heavy snowfall, hence with a high relative humidity, the calcium chloride solution is used.

The new sodium chloride storage facilities at the Citerna Snow Station

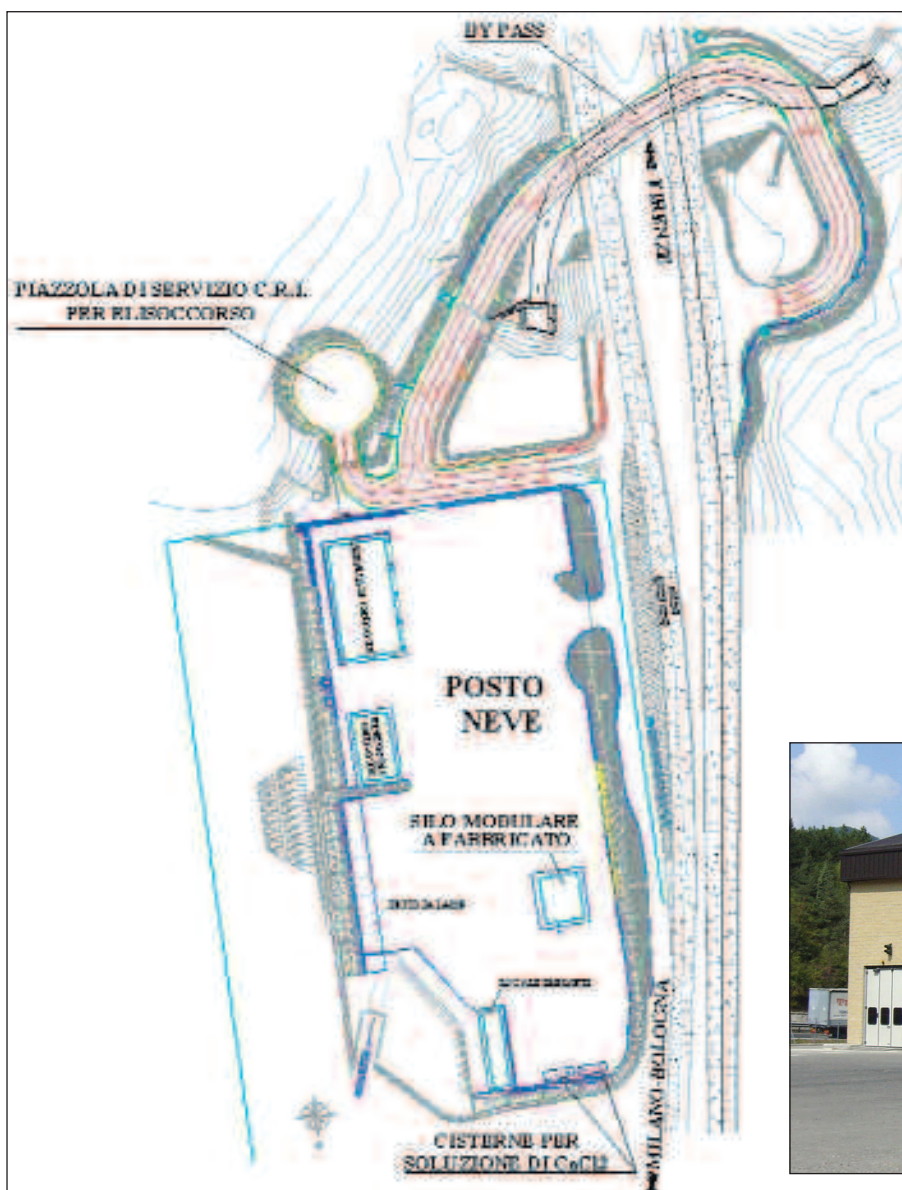
The Citerna Snow Station is the centre of operations for a large fleet of vehicles and machinery: 11 spreaders, 16 snowploughs and four road sprinklers. Because of its role, Autostrade per l'Italia decided to equip the Citerna Snow Station with an advanced system for the storage of solid deicers (sodium chloride). The storage facility would have a high capacity (750 tonnes) enabling the spreaders to be loaded within a very short space of time.

To comply with a several urban planning requirements imposed by the municipality of Barberino di Mugello regarding the structure's height and its covering, the decision fell on the European-patented system

from Agristrade, which represents a further technological development since it had been adopted by "Autostrade per l'Italia" in other instances. In fact, the positive experience of the Direzione III Tronco di Bologna, which has benefited from this technology for the last two years, was a determining factor in the adoption of this new type of facility. Traditional cylindrical silos developing vertically (three facilities installed in Bologna) have evolved into a building type facility offering greater storage space, but a reduced environmental impact. This type is already being used by other road management companies with positive results.

Description of the facility

The facility is essentially square-shaped (14.70 m x 15.00 m including outer curtain wall). It is made up of six contiguous modules, each of which has a discharge hopper. The roof, given the altitude of the Citerna Snow Station (726 m above sea level) and the heavy snow precipitation, has two pitches slanted at 18° on the horizontal and reaches a height of 12.6 m at its tip. The vertical walls of the structure are covered with a special split brick curtain wall, and the roof includes insulated panels in corrugated sheet steel with a dark brown paint finish.



The cylindrical silo with cone discharge



The building type silo with hopper discharge





Discharge operations

When the operator behind the wheel of the spreader approaches the silo, he is guided by an outdoor traffic light (green light) to the correct passageway and by the indoor traffic light (green light) underneath the hopper enabled for discharge.

These operations are managed by a computerised system which determines and processes the data from the weighing cell, then identifies and signals the hopper with the highest load. By constantly varying the points of discharge, this discharge method allows uniform levels of the salt to remain in the tank. A special infrared sensor automatically notes the correct position of the spreader and an alarm sounds to give confirmation to the driver.

The driver gets out of the vehicle, then to start the discharging process he enters a personal ID code on the auxiliary control panel and selects the quantity desired on a menu. The procedure is very similar to a cash withdrawal operation at an ATM machine.

At this point the system activates the process for a quick and precise discharge of the salt (approx. 1 minute for 8,000 kg), then stores in memory and prints out all discharge data.

Loading the facility

This operation is fully automatic and easy to perform: the driver is given the ok by the traffic light to connect with a quick coupler the feeding of salt from the tank truck to the correct loading pipe of the two in the facility.

The computer logic previously described processes the data of the weighing cells by automatically activating the rotating distributor of the less full sector. The two distributors that are part of the silo equipment are positioned inside the silo and flanged to the extremity of the loading pipes, which guarantees a correct levelling of the salt in the tank. All loading data are stored into memory, archived and printed out by the system.

Managing the facility

The facility features many controls and statistical management

operations, thanks to the constant self-diagnosis of the entire facility (controls on all malfunctions and information for their resolution), the recording and memorisation of relative parameters at each salt discharge operation (data, time, operator, quantity discharged, method of discharge and eventual malfunctions) and loading of the tank (date, time, quantity at the start of loading, quantity at the end of loading, total quantity loaded).

The maintenance centre manager can therefore, through key selectors on the main computerised control panel and a personal ID code for accessing the software, manage a wide range of operations and controls, including:

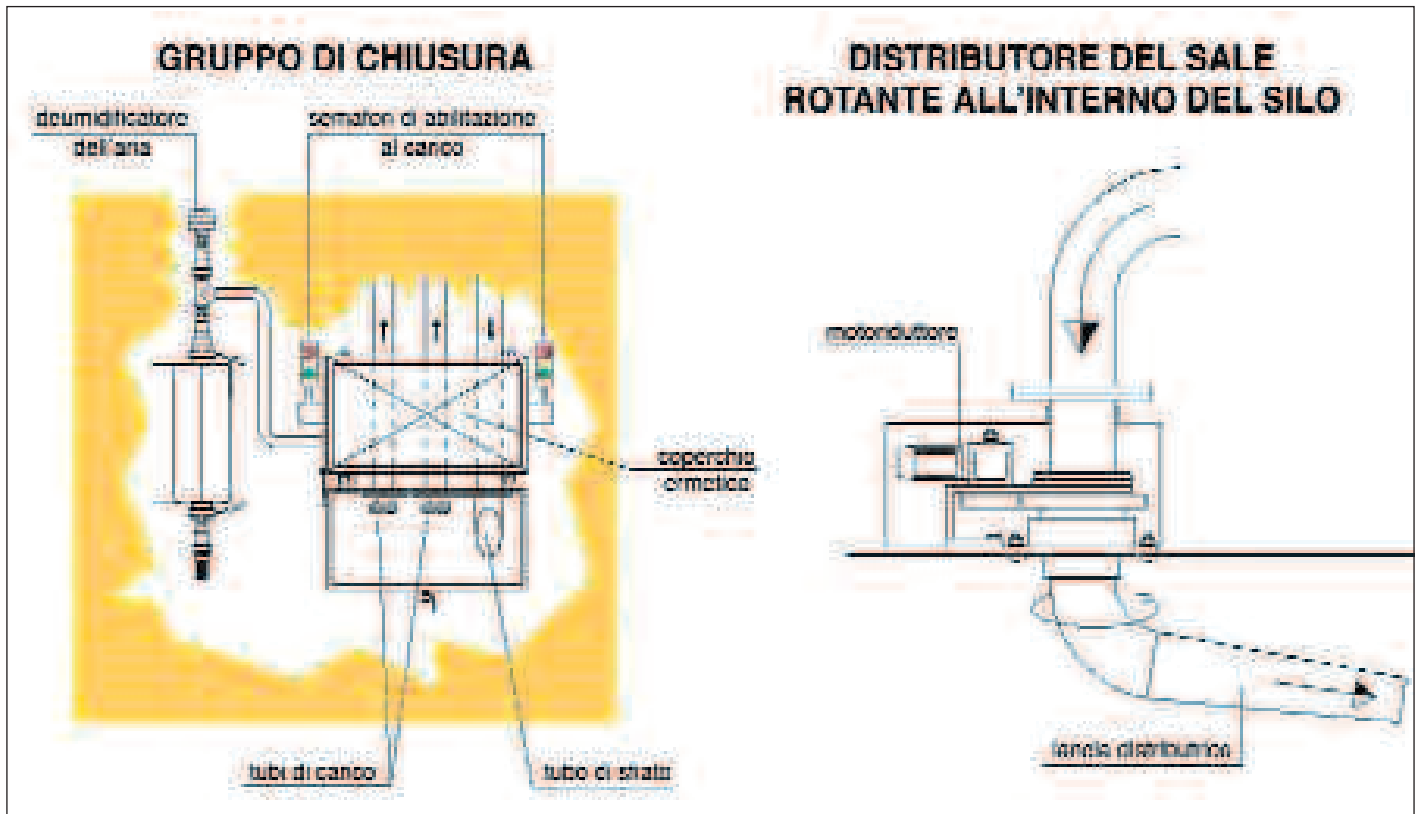
- ◆ Setting of automatic or manual operating mode
- ◆ Cut-out of individual hoppers for maintenance or other reasons
- ◆ Transfer of commands to the secondary external panel
- ◆ Control of malfunctions
- ◆ Insertion/modification of operator codes
- ◆ Counters reset
- ◆ Silo filling status
- ◆ Printout management (this function allow a full statistical control of all loading and discharge operations performed by the operators)
- ◆ Data saving
- ◆ Data restore
- ◆ Test of load cells
- ◆ System shutdown
- ◆ Date and time update

Also important to remember is that part of the statistical management mentioned above can be performed by modem through a remote control system incorporated into the existing one for the other saline solution storage systems, also by the offices of the Direzione IV Tronco di Firenze to systematise the use of the facility and provide for the prompt replenishment of deicer.

Facility improvements

The fast-paced technological developments, especially as concern electronics and our specific requirements aimed at satisfying special operating requirements, have led to improvements in electronics and computer applications with respect to earlier facilities.





Uniform discharge from the hopper

The software, for example, offers the possibility for the facility to be used by 31 operators, instead of the 15 allowed for other facilities. The need to extend access to the silos of Citeria to 31 operators is due to the strategic location of the Snow Station, which may also be used by other spreaders operating in adjacent sections of road and also to handle future maintenance operations that fall within the duties of the Citeria Snow Station, including the Variante di Valico stretch of motorway (between Pian di Voglio and Riveggio) soon to be built.

The charging of the pressure accumulator, which must take place prior to each discharge to guarantee an instantaneous stop of the salt during an emergency, has been sped up to 15 seconds as opposed to the 40 seconds required beforehand.

The infrared sensor, which exclusively controls the presence of the vehicle under the gate enabled for discharge, now sounds an alarm alerting the operator that the vehicle has reached the correct position.

Testing has also been carried out of another interesting new feature, which provides for the automatic recognition of the spreaders by means of receiving antennas on the facility and electronic "badges" on the vehicles (Telepass type). This facilitates operations even more by eliminating the need to enter the code and choosing the quantity of salt.

These last three options have been adopted, or will be, as a way to speed up the discharge operations, reduce downtime to a minimum and eliminate part of the operations performed directly by the drivers of the spreaders, in this case who may perform all operations without exiting the vehicle.

The constant quest for optimising and implementing advanced systems for the improvement of the vehicles' performance is even more important along this Apennine section, which is particularly challenging due to the high volume of traffic and of extreme importance for successful winter roadway management.

The latest generation computers and process controllers included with the facilities have features that permit real time management of many processes in course.

One example is that only slightly more than 4 milliseconds are necessary for running a "cycle" for reading and processing (which includes the querying of all 20 load cells of the weighing system, calculation of the weight of each hopper, identification of the salt distribution in the tank, the total weight of the salt in the tank, self-diagnosis of all components of the facility and the supervision of any active loading or discharge operations). This corresponds to 233 "cycles" of reading and processing per second, which gives an idea of how immediate the controls are during the rapid phases of salt discharge. The programmable terminal of the auxiliary computerised control panel provides for future implementations, such as the management of four telecameras positioned near the facility, the Maintenance Station or in more remote positions (tunnels, motorway sections, crossings, etc.) The software now makes it possible to clearly separate the management of manual discharge from automatic discharge.

Discharge management

The discharge gates have manual shutters that enable the section of salt to be varied, even for much smaller spreaders.

These are already set up for future automation for a potential self-service operation of the facility, which allows recognition of the vehicle of the outside administration and the consequent automatic matching of the discharge section.

Conclusions

Choosing a building-type facility can offer, as compared to traditional cylindrical silos (although they also contain sophisticated technology and are used by Autostrade per l'Italia), significant operating advantages, as summarised below:

- Because the facility is modular (the facility described here is composed of six modules totalling a capacity of 750 tonnes) there are no limitation on storage. For example, the maximum capacity of the cylindrical silos for the preservation of salt does not presently exceed 500 tonnes;

Total (manual and automatic)

- ◆ The power used for such high discharge quantities (8 tonnes/min.) is only 1.5 kW and is used only for opening and closing the gates, which can be estimated at 3 seconds.;
- ◆ The highly reduced discharge time translates into a rapid and effective road maintenance. This means clearing carriageways as soon as possible to allow safe travel for

Manual onlyAutomatic only

motorists and their passengers. Everyone knows that the rapid salt spreading of the pavement avoids or reduces to a minimum the related problems, slow-downs and/or accidents with serious consequences to road circulation:

- ◆ The special shape of the hoppers, which allows the salt to be spread uniformly along the spreader tank, avoids having to move the vehicle to prevent the salt from forming into one heap, a characteristic of cylindrical silos with a cone;
- ◆ Certainty of discharging the salt under any condition; even should one gate become obstructed, the vehicle can move to move underneath one of the other five;
- ◆ Loading of the spreaders is carried out in an environment protected from adverse weather conditions;

- ◆ Possibility of using the passageways of the building for storing other machinery or for other purposes.

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