# LOW NOISE WHEEL: FROM DESIGN TO APPLICATIONS

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**ABSTRACT**: Lucchini started the development of *Syope*® treatment in 1997, after some preliminary studies on other treatments to reduce noise emission from railway wheels. Since then, numerous tests, applications and results were obtained on high speed and conventional railway vehicles. This paper describes the development of the product, from the early findings to the latest applications that "close the circle" with the positive feedbacks from the field.

**KEY WORDS:** Wheel Treatment, Noise Reduction, Damping Techniques

## 1. INTRODUCTION

It is recognized that both the permanent way and the rolling stock emit significant portions of railway noise. The University of Florence and Lucchini Sidermeccanica independently started their works on railway noise in the early '90s. In those times, the University developed and tested, in the frame of a cooperation of the Italian State Railways (FS), a device to be mounted under the axlebox of several vehicles (ETR500, E402, UIC-Z coach) that proved to be capable to measure the noise emitted by the wheel with an excellent statistical reliability [1].

After the successful development of the device by means of tests conducted on the prototype trainset ETRX500, FS ordered in 1994 the University a measuring campaign where three different types of low noise wheels where tested under the ETR500, i.e. the low-weight "standard" high speed wheel (for ETR460, ETR480 and ETR500 trains), a wheel with ring dampers and a wheel with spokes [2]. The results were confirmed by independent trackside measurements made by the FS test department (Istituto Sperimentale FS).

Lucchini was the producer of some of those wheels and expressed in 1995 the will of setting up a cooperation with the University of Florence on railway noise in order to apply the technologies available at that time to reduce the noise emitted by its products.

The first step was to set up a fully equipped laboratory of vibroacoustics, comprising all the instrumentation available at that time for the complete characterization of the noise emitted by wheel. A semi-anechoic chamber was designed, built and tested, while newly recruited personnel was trained by means of specific classroom teaching and hands-on session on real products.

Initially several solutions were tested with alternate results. The ring-in-a-groove damping treatment was at that time recognized as useful only to reduce squeal noise and its efficiency was expected to be low; nevertheless the analysis of different ring damped wheels proved to be a good training for both the personnel and the entire equipment, especially in terms of data processing to find out damping and sound power. Although not normalised even today, a procedure developed at that time, i.e. the estimation of the total and normalized sound power spectrum [3], was later acknowledged by the industry as a suitable procedure to validate calculations made with noise simulation packages and tests conducted in the semi-anechoic chamber.
Times were mature in 1997 to start the development of a different type of damping treatment, that was named by the Greek goddess of silence: *Syope*®.

## 2. THE *Syope*â TREATMENT

### 2.1 Introduction

Wheel damping can be obtained in several ways, which will not be discussed here. From the literature it was known at that time that both the track and the vehicle emit significant part of rolling noise and that the wheel-rail contact patch is able to supply a so-called "rolling damping" which must be largely exceeded to get a significant reduction of the noise emitted by the wheel.

Similarly, as the wheel is only one the components producing noise, the overall noise will be decreased only by the relevant portion [4]. This makes the use of wheel damping particularly promising only where track has an intrinsically low-noise formation, and especially at high frequency and at high speed, where simulations indicated that wheel was the dominant sound radiator.

Lucchini identified the well-known constrained layer damping solution as the only feasible as:

- the treatment was expected to be automatically approximately equally effective on all wheel eigenmodes, while other treatments need to be 'tuned' on the specific wheel eigenmodes. Similarly, the treatment was expected to be relatively independent from the wheel tyre thickness modification after reprofiling, that significantly changes wheel modes (see a later paper, [5], for a proof of this statement);
- the treatment is self-centring and radial centrifugal forces are supported by the metallic panel and not by polymer, virtually eliminating any stress during the service;
- it was expected to possibly apply the treatment to any axial symmetric wheel without modifications to the current geometry, virtually without changing the design and applying the treatment to replacement wheel;
- the peculiarities of the treatment let suppose that no structural modifications were introduced in the wheel and that no safety analysis would have been necessary to be performed on the treated wheel.

At the same time, Lucchini was aware that:

- it was necessary to find out a polymer with extremely good properties, considering the expectations in terms of lifetime in service of a wheel (up to five years) and the extremely demanding conditions of the railway environment;
- the only possible mounting of the wheels on the axle is the press fit one, while shrink (hot) fit normally in use in Italy was not possible as the polymer could not survive to the 200-250° C heating;
- the treatment is only possible for disc-braked wheelsets as block braking introduces too much heat in the wheel tread that is transferred to the wheel web damaging the polymer.

All of these problems were carefully considered and Lucchini started the development of the *Syope*® treatment initially as a premium solution for high speed trains. Only after many years the market would have appreciated the product as a valid solution for ordinary service and for light railways.

### 2.2 Description of the *Syope*â treatment

Basically, the treatment consists of a steel layer constraining a special adhesive polymer sheet. The polymer was developed by 3M for aerospace applications and was selected after a careful evaluation of mechanical, chemical and physical properties. Such a polymer based on acrylate technologies has several important features that gave many industrial applications the possibility to solve not only sound reduction but also bonding aspects and sealing needs.

The polymer has a special structure completely homogeneous in every part, this structure has during the application process micro movements that fill all the microprofile of the materials involved with a strong improvement in performances also just after a few minutes from the application. This aspect can solve also many of the problems due to thermal differentials, especially when the materials bonded together are not the same and then are affected by different contraction or expansion; this is one of the reason of choice in aerospace applications where the thermal variation is wide and fast.

The product does not contain volatile or corrosive components so the surface covered with the polymer does not suffer absolutely any chemical corrosion also along the years. Splash tests conducted in U.S. certify good resistance when the join along the thickness is cleaned with the normal industrial cleaning products.
Nevertheless being the product a “solid glue” it has been possible to cut the polymer in the correct shape without the problem of perimetral adhesive excess and does not require special attention during deliveries and during the joint life.

### 2.3 Laboratory Vibroacoustics Tests

Although the validation of the damping treatment in terms of reduction of response vibration amplitude at the resonance were quite easy to be assessed, the efficacy in reducing the noise emitted by the wheel needed a different method to be proven. As for all sound measurement, a free field with a low background noise was needed. These conditions are not easily found in industrial plants, and Lucchini and University of Florence cooperated to design a semianechoic chamber that was finally certified as compliant with the international standards on sound power emission [6].

The normalized sound power emitted at each natural frequency was determined by using the already mentioned procedure. It consists of collecting the output of an array of microphones mounted on an arc centred at the wheel centre, with the wheel resting on a “soft” support and giving an impact with an instrumented hammer. Ensuring that the highest natural rigid frequency of the wheel on its support is lower than 1/3 of the lowest elastic mode of the wheel results in the so-called “free-free” response of the wheel, i.e. the impact gives an initial speed to the excitation point but the wheel is then free to vibrate without both other excitation and constraints. As the floor is reflecting, the entire sound energy is measured by the microphones.

The output from all the microphones is properly added to estimate the power output from the hemispherical surface defined by the rotation of the array around the wheel axis. Using reciprocity theorem, the arc of microphones was kept standing while the impact point was moved around the circumference. The total power was normalized with the excitation, resulting in the estimation of reduction of noise from the wheel in service (Figure 1).

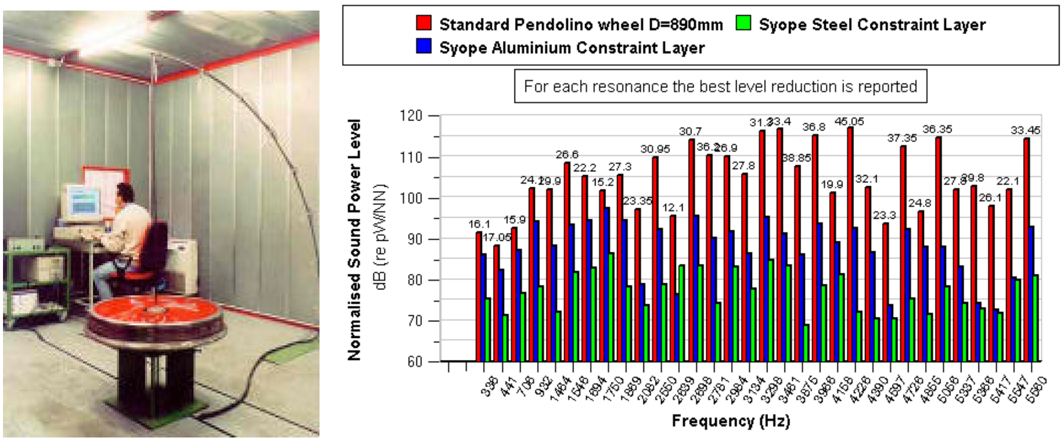


**Figure 1**. The semianechoic chamber in Lovere with the arc array of microphones (left). Normalized sound power levels obtained in 1997 for the Italian Railways high speed wheel (monobloc, curved web, d=890 mm) with steel and aluminum constraining plate. Reductions obtained at each frequency with steel plate are shown (right).

These data were considered very promising but were believed to be only partially reachable in practice for the already mentioned existence of “rolling damping”. Thanks to a cooperation with Fiat Ferroviaria, it was therefore planned a set of line tests with the test trainset ETR470-0.

## 3. 1997: HIGH SPEED TESTS WITH ETR470-0 TRAINSET

ETR470-0 is a tilting train of the Pendolino family that Fiat Ferroviaria was using at that time as a test train to develop different technologies. Lucchini supplied 4 wheelsets with *Syope®* treatment with steel constraining plates. Test runs up to 250 km/h were performed and noise emission was measured with conventional standing microphones and with a linear array of microphones in order to horizontally separate the sources (Figure 2).

**Figure 2**. Left to right: experimental *Syope®* wheels on the ETR470-0 trainset, trackside microphones during a 250 km/h pass-by, preparation of linear array of microphones.

A pass by at 220 km/h is shown in Figure 3; the presence of an additional source, installed to develop a computer program able to remove the Doppler effect and to identify the wheels, emitting noise at exactly 2 kHz is evident near the front driver's cab. Noise reduction during a pass-by at 220 km/h is shown in Figure 4. Although it is evident that the exceptional results obtained in the laboratory tests were not reached, the around 5 dB(A) reduction was considered very promising and the results were presented to FS on 13 May 1999.

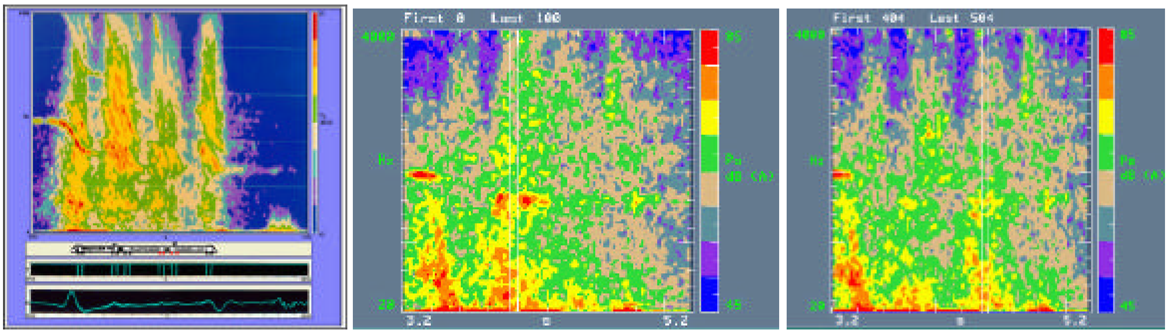

**Figure 3**. Left to right: time-frequency analysis (spectrogram) average on 21 microphones, analysis of a standard wheelset and analysis of a *Syope®* wheelset.

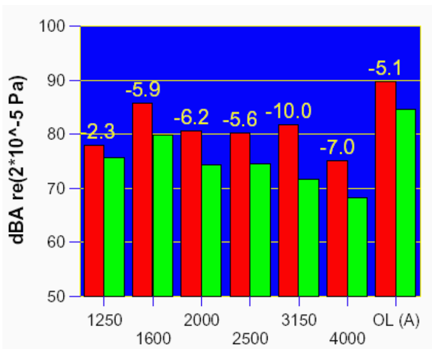


**Figure 4**. One-third octave band and overall noise levels measured during a pass-by at 220 km/h of the ETR470-0 trainset. Data for untreated (red) and *Syope®* treated (green) wheels.

# 4. QUALITY ASSURANCE CONSIDERATIONS

As the activity on *Syope*® wheels was progressing fast, it was decided in 1999 that all further activities had to be conducted in the respect of quality assurance rules. Lucchini developed four technical specifications [7,8,9,10] to standardize the supply of the polymer, of the steel sheet and of the complete screen. Also the mounting process was adequately described.
At the end of 1999, the Technical Report on the Syope Project [11] virtually closed the experimental phase opening the industrial application phase of the product.

# 5. 2000: HIGH SPEED TESTS WITH A ETR500 PLT TRAINSET

## 5.1 Introduction

After the results obtained with the ETR470-0 trainset, the newborn FS Trenitalia Unità Tecnologie Materiale Rotabile (UTRM, Rolling Stock Technology Unit) decided for a more extensive and precise noise measuring campaign. At that time a trilateral cooperation of the main European Railways (DB, FS, SNCF) was setting up a high speed campaign in the three countries to investigate the aerodynamic drag at high speed and the influence of bogie fairings to reduce energy consumption of high speed trains.

Times were mature to test *Syope*® wheel on the new multivoltage ETR500 PLT trainset number 51, and Trenitalia contacted the University of Florence to perform on-board and trackside noise measurements on his behalf. A great advantage was resulting from the fact that also technicians from DB were in charge of measuring trackside noise with a spiral array of microphones that was able to efficiently separate the sources in both vertical and lateral directions.

The train was prepared in order to solve one of the main limitation of the ETR470-0 campaign, i.e. the different roughness of the standard and *Syope*® wheels. Most of the wheels (approx. 75%) were reprofiled at a time in Milano Fiorenza workshop, and tests on the Roma-Firenze Direttissima line started two weeks after, when the train had run approximately 3000 km. Incidentally, this is the same distance that will be recommended by [12] around five years later.

The coincidence of the aerodynamic drag test campaign allowed the test of all the combinations of the following parameters:

- speed, in the range 195-300 km/h;
- fairings (with special acoustic treatment);
- *Syope*® wheels;
- reprofiling.

## 5.2 Results

The results were processed and published independently by Trenitalia - University of Florence [13] and by DB measuring group [14] and can be summarized as follows: in the 190÷295 km/h range, the use of *Syope*® treatment reduces the noise by 4 to 5 dB(A), offering similar or better performances compared to fairings. Speed confirmed its importance while turning the wheels reduced by approximately 2 dB(A) the noise emitted by standard wheels. The advantage offered by *Syope*® wheels is better at the lower limit of the speed range tested, as fairings are particularly efficient at the higher speeds where aeroacoustics noise becomes prevailing.

The train composition and the typical noise “signature” from the pass-by are shown in Figure 5, while photographs and results are shown in Figure 6 and in Figure 7.

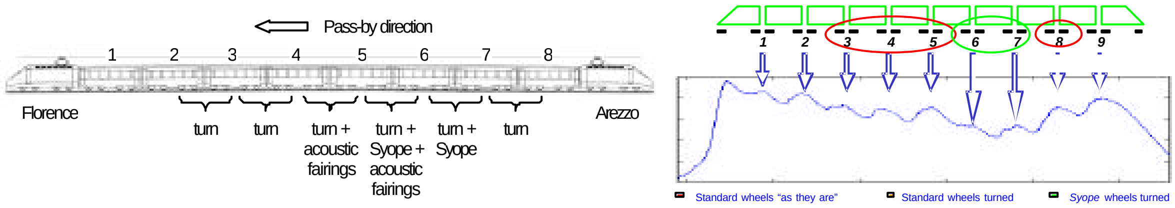


**Figure 5**: Composition of the test ETR500PLT-51 trainset (left) during the test campaign in Renacci, 2000 (left). The typical noise signature ($L_{pAmax,F}$) at 7.5 m of a pass-by is shown on the right, where the effect of wheel reprofiling and *Syope*® wheels is evident.

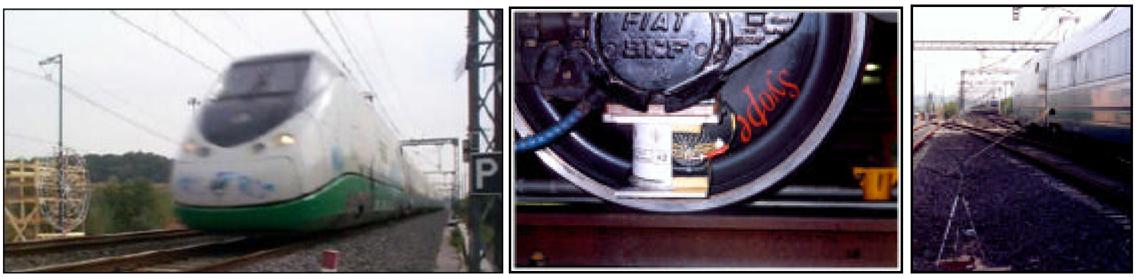

**Figure 6**: Some images from the test campaign in Renacci, 2000, on the ETR500 PLT trainset 51. Left: train passing by in front of the spiral array of microphones by DB; mid: axlebox noise measuring device developed by University of Florence in front of a *Syope*® wheel; right: classical standing microphone at d=7.5m, h=1.2 m from the track centerline.

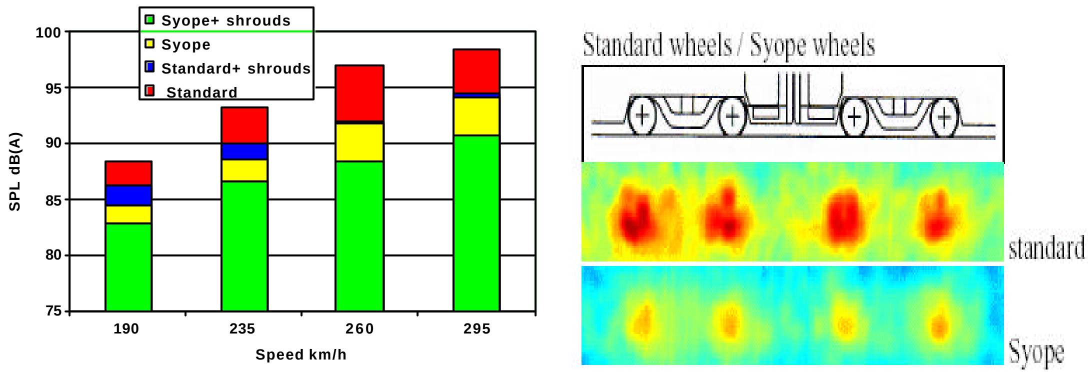


**Figure 7**: Noise emission comparison between standard and *Syope*® wheels, found by (left) University of Florence - Trenitalia and by (right) DB.

After the completion of the test campaign, it was decided by Trenitalia UTMR to leave the wheelsets in service. A first check was done on 18 February 2002 at Milano Fiorenza depot, after approximately 200.000 km, and it was found that no damages were visible on the *Syope*® panels. It is worth to note that the coach number 7 in the experiments (90 83 5 889 200-2, Bar-Dining Car, one bogie with *Syope*® wheels) had in the meantime become part of ETR500PLT-31 and was therefore not inspected.

## 6. 2000: LOW SPEED TESTS ON A NARROW GAUGE LIGHT RAILWAY

While all the tests shown up to now were conducted on high speed train, Lucchini Sidermeccanica was facing also the problem of noise reduction at lower speeds. This task is even more challenging, as it was known and accepted that at low speed the track becomes the dominant source and that remedies taken on the wheel can be of low or none effect.

Lucchini supplied *Syope*® wheels for two different type of trains of Circumvesuviana, a local narrow gauge (950 mm) light railway with a very intense traffic situated in Naples area. The

network, 140 km long, crosses densely populated areas where the disturbance induced by noise can be significant.
Extensive test campaigns were done in the 50-90 km/h range, showing a reduction of the overall rolling noise of 4 to 5 dB(A) also in this lower speed range, without any modifications to the track [15].
A special problem that affects most of the trains of Circumvesuviana is, moreover, squeal noise in some narrow curve close to a couple of luxury hotels whose customers were strongly complaining about high level tonal noise especially at early morning. Although it is recognized that squeal noise is an erratic phenomenon, that often appears and disappears without a specific and clearly identifiable reason, it was not observed anymore during pass-bys of the trains equipped with *Syope*® wheels (see Figure 8).

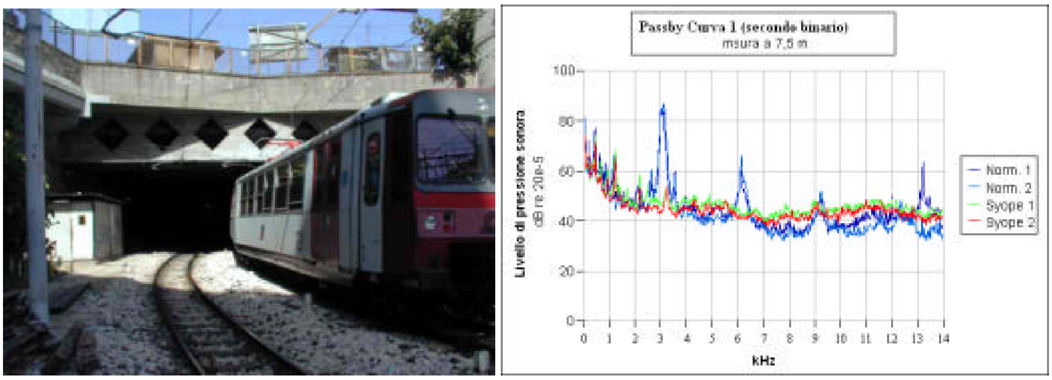


**Figure 8:** A Circumvesuviana EMU train ETR200 negotiating a narrow curve close to Porta Nolana terminus station, just below a luxury hotel, where squealing is common (left). Noise spectra of ordinary ("Norm.") ETR200 compared to another trainset equipped with *Syope*® (right)

## 7. SAFETY CERTIFICATION BY ITALCERTIFER

It is evident that any modification applied to a wheel may compromise safety. Immediately after the decision of performing tests, Lucchini submitted to Italcertifer, the Italian body for railway certification, all the technical documentation about the project, including the aforementioned reports and technical instructions.

Italcertifer, with the support of Trenitalia UTMR, evaluated the test results and the documents and, also on the basis of service checks, released on 28 August 2002 the evaluation of the mechanical and acoustical properties of the *Syope*® treatment [16].

The most important conclusions that were reached can be listed as follows:

- "The *Syope* treatment does not require any geometrical or structural modifications to the wheels on which it is applied. The mounting of panels… does not require further mechanical mounting systems… as a consequence, it does not alter the resistance properties of the wheel and has no structural functions (therefore it is not subjected to external loads…)"
- "Mechanical and adhesive properties of *Syope* treatment… have been verified with lab and in-field tests following the reference standards."
- "The manufacturing and mounting process is defined by supply procedures and material checks, mounting procedures and final check procedures. These procedures allow to trace all the manufacturing and check phases of the *Syope* treatment."
- "Moreover, the wheel production process with *Syope* treatment differs from the standard wheel solely for the panel mounting phase"
- "We certify that trackside noise measurements reveal a noise emission reduction of *Syope* treated wheels compared to standard wheels. For the microphone placed at 7.5 m from the line centreline, such reduction is not lower that 4 dBA in the speed range 200 to 300 km/h… the emission reduction is particularly concentrated in the frequency range above 1 kHz."

- “Since December 2000 FS Trenitalia uses 16 wheels with *Syope* treatment on two ETR500 trainsets used for both tests and commercial service. We certify that these trainsets have been used up to 320 km/h and that up to now they have run approximately 300.000 km without any problem due to the *Syope* treatment”.

## 8. APPLICATION CASES

Lucchini presented at Innotrans 2002 in Berlin the results of the laboratory and line tests already mentioned. At that time, the reconstruction process of the Merano-Malles line, along the Venosta valley on the Alps near the Austrian border, was at an advanced stage. The line, formerly managed by Italian State Railways FS, was closed in the early ‘90s as it was considered not productive. The Autonomous Province of Bolzano decided to re-activate the line and was searching for a low environmental impact rolling stock. They finally chose a DMU articulated train manufactured by Stadler, Switzerland, that incorporates many state-of-the-art solutions. People in charge asked Lucchini to supply wheels with *Syope*® treatment, and the line was finally opened on 5 May 2005 and immediately got a great success, gradually almost replacing the coach services along the valley.

The train has the structure shown in Figure 9 and is capable of running at speed up to 100 km/h. Trailing bogies are quite conventional and are equipped with *Syope*® wheels (disc brakes on the axle), while the central motor car has brakes mounted on the wheel web, a solution that intrinsically offers a low noise. For new rolling stock of this kind (DMU), Italian laws [17] require a maximum $L_{pA,F}$ of 83 dB(A) after 1/1/2002 and 81 dB(A) after 1/1/2012 measured at 80 km/h with the microphone at 25 m from the track centreline (height=3.5 m).

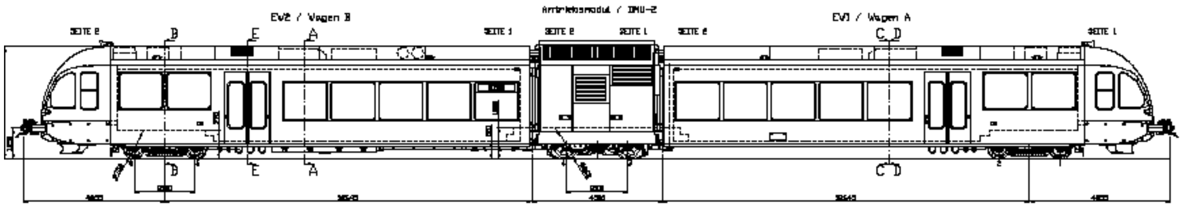

**Figure 9:** Stadler GTW 2/6 of Val Venosta regional railway.

Tests were conducted on 12/13 July 2005 on a line section with a very limited slope of approximately 2‰, a condition that allowed measurement with full throttle climbing up to Malles and with engines off descending down to Merano. It was therefore possible to evaluate the contribution of rolling noise to overall noise at full power.

The highest maximum level of noise of 79.0 dB(A) was recorded during a 100 km/h full power run, while the noise at 80 km/h with both the engines off was stable around 74.0 dB(A) [18]. These values are much lower than what is currently requested by Italian law and will satisfy also the requirements of 2012; moreover, the rolling noise contribution to the overall noise is particularly limited (9 dB(A) less than 2002 limit, 5 dB(A) less than overall noise) and contributes only slightly to the noise pollution.

Once again, what is satisfactory is the result obtained by a low speed regional train. It is worth to note that these results were obtained on a track with a roughness spectrum largely above limits stated by EN ISO 3095:2005.

Another noticeable application was the supply of high speed trainsets of the “Pendolino” type to Czech Railways. In 2000 Fiat Ferroviaria undertook an order of construction for ten tilting trains, but their number was then reduced to seven; the first set was delivered in 2004 as Pendolino CD 680 (Figure 10). While testing from Breclav to Brno on November 18, 2004, the Pendolino reached a speed of 237 km/h and created a new Czech railway speed record. Since 2006 the service was extended to Slovakia and Austria.

**Figure 10.** A Czech 680 Pendolino.

These trains are very similar to the prototype Pendolino ETR470 and the wheels were exactly the same; although no noise measurements were performed by Lucchini or by the University of Florence, there is no reason to forecast different results from those obtained during the tests in Italy. The Czech application is anyway noticeable as adverse environmental conditions brought to the light a feature that was not possible to observe in Italy, i.e. a high number of freezing and thawing out cycles that repeatedly allowed water to turn to ice and back leading to partial detachment of panels. This inconvenient generated a sealing procedure that was applied since then in all the subsequent wheels supply.

In 2005 Circumvesuviana decided to adopt the *Syope*® wheel as the retrofit standard for the entire existing fleet and for the new trains that are object of a tender. This is by far the largest single order of Syope wheels until now (totalling approximately more than 3000 wheels) and is particularly interesting as the Railway Administration will change the entire maintenance operation procedure (passing from shrink fit to press fit) with the inevitably associated costs that are anyway lower than those linked to the use of noise barriers.

More recently, the Train Operating Companies Trenitalia SpA (part of the Italian State Railways, Holding FS SpA) and Cisalpino AG ordered a new tilting train named ETR600 (12 trainsets) and ETR610 (14 trainsets) respectively and emitted a so stringent tender that the manufacturer (Alstom Ferroviaria) had to include the *Syope*® damping treatment.

This step is crucial as the European Directives assign to the Infrastructure Owner (RFI in Italy) the responsibility for noise pollution disturbance. The use of noise reduction measures at the source is therefore a noticeable example that fulfils the same legislation that states the noise reduction measures should be adopted preferably at the source and then on the acoustic path (leaving the measures on the receiver as the last option).

The first trains are currently undergoing homologation tests and no data are available from the noise emission point of view; a thorough investigation is planned in Autumn 2007 and the results will be presented at the next WCRR2008 conference in Seoul [19]. It is worth noting that the wheel changed radically from that used in the previous versions of Pendolino, and this will very likely lead to further improvements in noise emission reduction.

**Figure 11.** The Cisalpino ETR610-001 during a transfer run (13.06.2007)

# 9. PANEL STRENGTH AT THE END OF WHEEL LIFE

## 9.1 *Syope*® wheel recovery at the end of their life

Although external loads on the panel are mainly centrifugal and are supported by the mechanical structure of the panel (whose elasticity modulus is much greater than that of the polymer) and by the constraints given by the shape of the wheel web, some concerns remained about the effective durability of the treatment in real service.

Of the whole set of wheels installed in 2000 under ETR500 PLT-51, four wheelsets, i.e. those mounted on 1st Business Class Coach #6 (number 90 83 5 899 207-5, both bogies with *Syope*® wheels), finished their life under ETR500 PLT-56, were returned to Lucchini plant in Lovere and were treated as normal steel scrap.

Thanks to the cooperation with the Maintenance structure of Trenitalia, it was instead possible to monitor the status of other four wheels, i.e. those mounted on 1st Class Coach #7 (number 90 83 5 199 212-2, one bogie with *Syope*® wheels). These wheels where collected at the Trenitalia Workshop in Vicenza at the end of July 2005 at the end of their useful life, i.e 1.100.000 km and five years after they were mounted in 2000.

Once again, Trenitalia recognized [20] that the use of *Syope*® wheels had been absolutely "transparent" to the final user, also on a high value train that was regularly inspected: "About maintenance aspects, the life cycle of mentioned wheelsets was absolutely identical to that of all the other wheelsets used on ETR500 trains…". Nevertheless, an overview of the panel conditions in the workshop showed that external panels had some parts that were apparently detached. It was decided to keep the wheels back to Lucchini Sidermeccanica laboratories in Lovere to verify, after a full life, the final conditions of the constraining panel.

## 9.2 Panel tear tests at the end of wheel life

As the external action on panel is due to the combination of the centrifugal force and vertical vibrations (peak and random) induced by actual wheel rolling on actual rail, it is readily understood that these actions can never produce a detach of the panel. It was therefore necessary to "invent" a test procedure that had no resemblance with reality trying to tear off the panel from the wheel web. Several decisions were taken:

- the external action should have been able to detach the panel from the wheel, i.e. it had to be applied along the wheel axis;
- no mechanical action was permitted on the panel before the external action is applied, i.e. it is not possible to make bores, threads or other fixing surfaces;
- no thermal loads had to be applied on the panel, i.e. any welding to the panel is forbidden.

The only possibility left was to bond a disk on the inner border of the panel, where the surface is minimum and hence the possibility of detaching the panel is maximum. A structural glue was chosen and two rings, one for the internal panel and one for the external panel, were prepared. The rings were rigid enough to avoid deformation during tension tests and were pulled by a statically determinate system of chains and rings. The system is shown in Figure 12 and in Figure 13.

**Figure 12.** Tear test preparation. Left: the glue is applied to the internal ring. Mid: curing time was min. 24 hours. Right: Universal traction machine with Syope wheel mounted ready for tear test.

**Figure 13.** Results of tear test on the internal panel (the ring detached at 51 kN without detaching the panel, above) and on the external panel (the ring detached at 21 kN without detaching the panel, below)

From these tests it was concluded that the reserve of safety was still largely sufficient and that five years of service of the prototypes were not sufficient to reduce the adhesion properties of the polymer. As a result, safety is absolutely guaranteed in any railway application.

## 10. CONCLUSIONS AND FURTHER DEVELOPMENTS

*Syope*® treatment underwent a decade development, including all the aspects of research, development and industrial processes. As a result, it proved to be a safe and reliable noise reduction treatment that preserves its functionality for the full life of the wheel.
Although technical aspects are certainly a prerequisite for any wheel related product, recent findings show that also Life Cycle Cost analyses [21] are favourable, highlighting how the impact of this measure is advantageous compared to noise barriers.
The blending of advantageous technical and economical issues are the reason for the continuously increasing success of the *Syope*® product.

Italian State Railways FS policy not only forecasts the use of noise barriers installed by RFI (infrastructure owner) but starts introducing the concept that also mass produced trains for the main train operator Trenitalia can be effectively equipped with noise reduction devices that can avoid the use of noise barriers in “border” noise pollution situations. This is a major leap towards the total and combined approach towards the reduction of railway noise, that can be reached only through the deep cooperation of all the actors involved.

Following the commitment to always provide the market with technologically advanced and safe products, Lucchini Sidermeccanica is currently developing, with the continuous support of the University of Florence and of its main customers, other solutions for tread braked wheels [22] and for wheels with discs mounted on the web [23].

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