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RESEARCH EVOLUTION ON NOISE PROBLEMS CONCERNING THE HIGH-SPEED SYSTEM OF ITALIAN RAILWAYS

Pietro ROMANI - Francesco VENTURA

ITALFERR SIS.T.A.V. S.p.A
Via Lamaro, 13 - 00173 ROME - ITALY

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1. INTRODUCTION

Since 1987 the Italian Railways, within the High Speed project regarding the cities of Turin, Milan, Bologna, Florence, Roma and Naples, in accordance with EEC Directives and the Italian law on environment, have started the Environmental Impact Study to be submitted to relevant Public Authorities.
At the same time, the Italian Railways have undertaken a systematical research through an investigation and testing work which had the following objectives:

- location of noise sources
- mitigation of noise levels at the source (active measures)
- appraisal of compliance with environmental laws.

The studies of environmental impact pointed out also problems related to the noise produced in the yards, particularly in city areas.
Also for this reason, some phonometric surveys were carried out in potential yard areas defined by the same environmental study (Rome area), and an analysis was made of the related noise levels expected to be produced in the work in progress stage, by applying the U.S. analytical models of the Federal Highway Administration.

2. EVOLUTION OF THE RESEARCH ON ETR 500'S NOISINESS

Since 1992, the Italian Railways have largely promoted studies and researches on the phenomena associated with the environmental noisiness the last generation trains.
By that time, in fact, the results of tests carried out on the first prototypes of ETR 500 (high - speed train) were not completely satisfactory, showing Leq indexes higher than 100 dBA measured at 25 meters.
As first, the potentially most significant noise sources defined as follows:

- wheel - rail contact
- pantograph - electric line contact
- auxiliary equipment (ventilation, accumulators)
- aerodynamic noise.

The acoustic condition of ETR in September 1992 is represented by the curve with 2 peaks at 97 dBA at 250 Km/h with unturned wheels. Further differences were pointed

out in relation with the different braking systems: disc and clasp brakes made of cast iron. The ETR 500's locomotive is equipped with both types of brakes, while the carriages have only disc brakes.
By turning the wheels of one of the two locomotive one could reduce the noise level down to max 90 dBA. By turning also the wheels of three carriages and of the second locomotive one could obtain 88 dBA, that is 9 dBA lower than in the condition of unturned wheels.
By comparing the Pendolino (ETR 450) with ETR 500 and Intercity, it was observed that first class carriages produce a noise level 10 dBA higher than second class carriages, since first class carriages are heavier, thus requiring cast iron clasp brakes.
Further, a test was conducted on the Florence-Rome railway section concerning the trains operating at present, with various combinations of brake types.
It was observed that, by applying sintered clasp brakes, also utilized on TGV,and activating all brakes, three carriages with turned wheels and three of them with unturned wheels, and comparing the results after 2.000 Km, a noise increase was obtained in terms of 8 dBA at the trailer site, where the cast iron clasp brakes were located, while an increase of 10 dBA was recorded at the sinterized clasp brake site.
Therefore, the problem is not how to obtain the lowest level, that is 88 dBA, but how to maintain such level, since after 200.000 Km the noise level grows up to approx 91 dBA measured at 25 meters. There is an intervention plan underway; the ventilation circuit has been modified in order to the low speed noise; changes will be made on the wheel, yet to be verified; modifications to the clasp brakes only in emergency conditions.
There is also a project for the development of a box made o deadening material for the bogies already tested by English technicians, who obtained a substantial noise reduction at 160 Km/h.
By using such box with a small screen, a noise mitigation of 3 or 4 dBA can be obtained, so as to reach a level of 85,84 dBA for ETR 500 at speed close to those at which the aerodynamic noise prevails.
Another solution underway is the application of absorbers to the wheels: extensive testing showed a reduction of noise level in terms of 3-4 dBA. In Italy first results show a further reduction of about 3 dBA. By this program we expect obtaining by the end of the current year a Leq of 85 dBA. In the medium term-4-5 years-we will test a new type of elastic wheels; nobody knows in fact how the rolling noise is produced and this could be a solution. After reaching 8 dBA it will be important to reduce the aerodynamic noise. Now it is not prevailing yet, but in the future it should be significant already at 250 Km/h. In such case the work on aerodynamics will be remarkable.
At present, studies are conducted at the Research Centre of Pininfarina, the project manager of the ETR 500, in the wind tunnel, in order to improve both the penetration coefficient (CX) and linear distribution of volumetric masses with special consideration for the connections between the carriages which are the major causes of aerodynamic noise.
No problems are caused by the contact between the pantograph and the electric line at current speeds, also due to the special features of the same pantograph connection with the carriage which are rather "low" in relation with the upper profile of the same carriages.

3. NOISE PRODUCED BY HIGH SPEED RAILWAY LINE YARD WORKS

As already mentioned, one of major aspects in EIS is the yard implementation and the noise produced by a number of machines and equipments for a long period of time.

The yard equipment related to railway infrastructures is associated with all the activities carried out in the yards, such as: ground levelling, preparation of the site, digging operations, soil clearing. The various works are usually executed in different stages; each of them involves specific machines and equipments and thus, specific noises. In order to establish noise levels produced in the stage of yard works a number of sample investigations were carried out, e.g. phonometric surveys and analytical simulations, so as to compare the LEQ (equivalent levels) in dBA of the post-operam stage (with yard in operation) with levels admitted by law and/or with those of the ante-operam stage.
The forecasting model was employed for the simulation with the aid of the calculation algorithm set up by the U.S. Federal Highway Administration. This model is an instrument which allows the evaluation of project choices undertaken by the civil work project leader in one of most difficult stages of both the approval procedure and the same life of the work. In this respect the model makes reference to the database officially recognized by EPA and set up by ARBA (American Road Builders Association).
Such database is being updated and adjusted to the Italian context, according to the emissive and typological characteristics of most common equipments utilized by Italian building companies.
The model provides some acoustic maps, with punctual indication, where possible, of the acoustic level in specific receptors, according to three different work stages:

- the first, if required, concerns the acoustic mapping of the noise level produced in the territorial section close to the yard area before work start;
- the second consists of the estimate of the noise level produced by each equipment utilized according to work cycles completed;
- the third allows obtaining total noise level integrated within the reference period considered.

It is to be pointed out that the results of the simulation take into consideration the circulation of light and heavy vehicles on the roads, the cyclical and stationary means operating in the yard area; cyclical and stationary equipments can be studied by a time analysis of the various work stages.
An example of the acoustic levels in an area potentially concerned by a yard is reported in Fig. 2 and refers to the Roman urban area.

4. CONCLUSIONS

As already said, the Italian Railways give great care to the problems caused by noise pollution of the new high speed trains, both through the EIS studies and an extensive field investigation on the newly developed means.
The good results obtained in the last two years allow continuing the researches in the order to furtherly reduce the noise levels produced by the new high speed trains.

5. REFERENCES

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Noise Pollution in urban areas: the case of city of Bologna in the noise study for the high speed railway. Proceedings of 1° Symposium Italy - Brasil April 1992
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Fig. 1 - SOUND LEVEL EVOLUTION OF "ETR 500" DUE TO THE EFFECT OF TURNING OF THE RAIL WHEELS

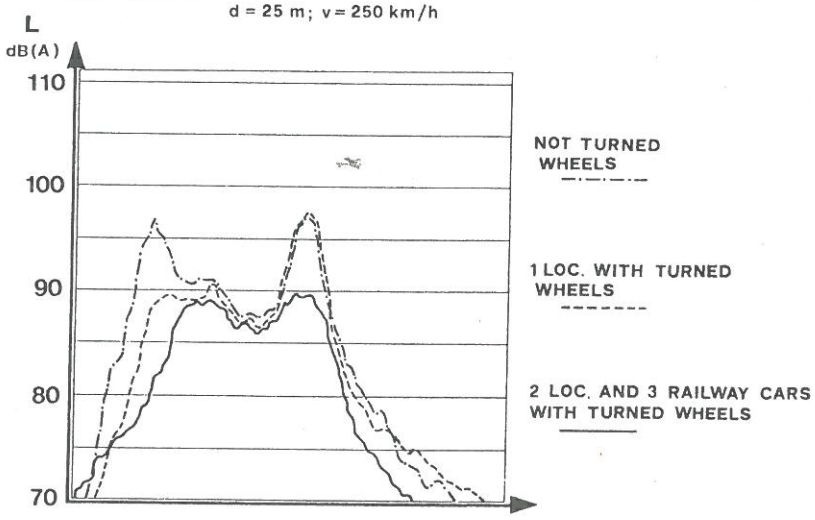

Fig. 2 - EXAMPLE OF NOISE MAP DUE TO CONSTRUCTION PHASE IN ACOUSTIC STUDY FOR THE NEW HIGH-SPEED RAILWAY