Vibration test on syte – Case study Palermo tramway

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ABSTRACT

The isolation of vibrations in the railway industry nowadays plays a primary role in the design, construction and testing of rail track system for city application. Over the years the awareness of the importance of a design that considers and protects the structures that add to the railway line from the effect of the vibrations caused by the transit of the trains has matured. Isolgomma has long been engaged in the study of technical solutions for vibration isolation in various fields of application including the railway sector. The experience gained has allowed us to produce and propose this article the case study of tramway of Palermo with the presentation of the design process and the evaluation of in situ measurements.

1 INTRODUCTION

The reduction of the vibrations generated by the transit of trams, in order to prevent their transfer to adjacent buildings, was the guideline for the construction of a new tramway line in the city of Palermo. For this reason it was decided to use a floating slab track system on continuous supports, which consists of concrete structure located on a resilient elastomeric mat. This configuration makes it possible to create an elastic / damped system that reduces the vibrations that can be directly perceived by people and buildings as irradiated noise.

2 DESCRIPTION OF SLAB TRACK SYSTEM

2.1 Design steps for the choice of the slab track system

A predictive study was performed for the assessment of vibrational levels. The values obtained led the designers towards the choice of floating slab track system on continuous resilient mat. The study was divided into several phases:

- Analysis of the propagation of vibrations through the soil substratum carried out through the execution of MASW tests in significant sections;
- Evaluation of the spectral density of the force transmitted by the trams used;
- Prediction of vibrations in significant points with comparison of exceeding threshold limits;
- Choice of floating slab track system on continuous support;
- Vibration prediction with floating slab track system and verification of non-exceedance of threshold values.

Source (Gianfranca Mastroianni, 2017)
Figure 1: Figures should be centred with the caption positioned below the figure

These technical steps have led, in relation to the threshold limits set by the reference standards, to the design choice of floating slab track system on continuous anti-vibration mat. The particularities introduced in this specific application are the direct connection of the rails to the reinforced concrete slab without the sleeper and the differentiation of the elastic levels: Rail wrapped by rubber profiles; Under rail rubber pad placed between fastening system; Under concrete slab anti-vibration mat with a thickness of 25mm. All Isolgomma products used were made from recycled material, in particular rubber from processing waste and from ELTs. The combination of these elements has allowed us to create a high-performance solution with a low environmental impact

2.2 Description of anti-vibration systems

The products used followed a strict test procedure for a complete characterization of the physical-mechanical properties. The rubber profiles have been tested according to the standards: ISO 868: Determination of indentation hardness by means of a durometer, Shore hardness A; CEI 15-23: Methods for measuring the volumetric and surface resistivity of solid electrical insulating materials; DIN 52102: Determination of dry bulk density; DIN 52103: Determination of water absorption; DIN 52104-1: Freeze-Thaw cyclic test, Method A; DIN 53428: Determination of the resistance to liquids, vapours, gases and solid materials. The anti-vibration mats, type Matrack M25AVc500, have been characterized by static and dynamic forced tests. These tests were carried out according to the technical supply specifications and in compliance with the UNI 11059 standard:

Quasi-static stiffness Kqs = 0.016 N/mm^3 - Forced dynamic stiffness kd = 0.036 N/mm^3

3 MEASURES IN SITU POST OPERAM

The measurement campaign for the evaluation of vibrations was executed with the entry into service of the tramway line. The tests were carried out both on sections with a mixed traffic area and with restricted tram area, these were also performed for the zones chosen in both configurations with and without the anti-vibration system. The vibrations were analyzed and returned in order to obtain the average post-operam spectra of the vibrations, the graphs of the oscillograms, the graphs of third octave spectra and the time histroy starting from the data recorded through the monitoring with the seismometric transducers.

4 FINAL REMARKS

The comparison between the expected project values and the results obtained by analyzing the different spectra obtained from the different measurement points made it possible to understand the attenuation levels of the vibrations registered for the following investigated sections:

- EISTEIN - straight railroad - restricted tram area - with and without anti-vibration system - Line 2, 3 and 4
- CALATAFIMI - straight and curved road - mixed traffic area with anti-vibration system - Line 4
- MODICA - straight and curved road - restricted tram area and mixed traffic area - without any anti-vibration system - Line 2
- CENTRAL STATION - straight and curved road - restricted tram area and mixed traffic area - without any anti-vibration system- Line 1

Analysis of the results shows the acceleration values measured in the intervention areas are less than 0.03 m/s^2, while in areas without an anti-vibration system, these values are between 1.2 and 1.4 m/s^2. The UNI 9614 standard for measuring vibrations in buildings and noise evaluation criteria sets the limits in terms of acceleration equal to 0.03 m/s^2. The outcome of the in situ tests made therefore confirms the goodness of the choice and the design made. The possibility of vibration isolation due to the use of a floating slab track system with an elastomeric mat has thus been demonstrated experimentally.

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