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**RESEARCH AND DESIGN: A NEW BASE FOR THE PIETA' RONDANINI  
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**Abstract - The paper concerns the design of a new base for the Pietà Rondanini by Michelangelo. The sculpture, since 1956 and up to a few years ago, was displayed on an ancient roman altar. The project consisted in designing a new exhibition for the Pietà inside the Ospedale Spagnolo, a hall of Castello Sforzesco, to improve valorization and conservation with a new high tech exhibition. The whole process offered a great opportunity to deepen how to face many potential hazards. One among, and over the others, is the environmental vibration issue, mainly due to car or railway traffic, but also pedestrian footsteps. The project aim was to design a new base which, not affecting the aesthetic architectural value of the exhibition, at the same time offered a good protection against both the environmental vibrations from the nearby subway lines and any possible earthquake shakes.**

**Key words: environmental vibrations, anti-seismic base, museum.**

## I. INTRODUCTION

Pietà Rondanini was finished few days before Michelangelo's death. Rondanini comes from the name of the roman family who owned the statue since 1774. In 1954 the statue was acquired by the municipality of Milan, and became part of the *Civic Collections* at *Castello Sforzesco*. In 1956 the architect group BBPR (Banfi, Barbiano di Belgiojoso, Peressutti, Rogers) was charged with the design of a new exhibition in the hall named *Sala degli Scarlioni*. The roman altar by Rondanini family was maintained, where statue was just laid on it, without any link. The decision to move the statue to the Ospedale Spagnolo had, as main motivation, the valorization of the sculpture. This choice has been awarded by a number of visitors increasing from 83.139 in 2014, to 267.108 in 2015, also thanks to 2015 EXPO in Milan. The environmental and structural situation

of the two halls are very different, as the *Sala degli Scarlioni* is in a very quiet castle area, conversely, the *Ospedale Spagnolo*, even if part of the Castello, is in an area more exposed to the city traffic, and close to two subway lines. Initially the project considered only two critical issues: environmental vibrations produced by the subway and by the transport operations to move the statue between the two halls. However, the echo of the earthquake striking hard Emilia Romagna in 2012 and clearly perceived in Milan, was still very strong: that's why the conservation authorities asked to increase the artwork protection, including earthquake vibrations.

## II. MATERIALS AND METHODS

**Designing the new base**

As known, Pietà Rondanini, is a marble group sculpture with remarkable verticality and critical stability: the center of mass projection over the base is close to the edge, some parts are almost completely separated from the main marble block and finally the contact surfaces statue-altar are very rough. The 3D statue survey, gave a detailed analysis of the mass distribution and of the center of mass position. A second critical element was the display of the statue on the roman altar, without any links between them. It was immediately clear that the altar could not be maintained as base for the new exposition. The new base has been, therefore, thought for a twofold protection: environmental vibrations due to the subway traffic and earthquake shakes. The main differences between the seismic and environmental vibrations phenomena are: the earthquake causes much higher vibration levels, but their probability of occurrence is significantly lower with respect to the traffic vibrations, having lower levels, though producing a continuous input.

Then the frequency band is lower for the earthquake, in the range from 0.5 to 35 Hz for the seismic waves, while the ambient vibrations span a band is from 15 Hz to 100 Hz. The main problem consisted in mitigating the two vibration kind with a single device.

### III. RESULTS AND DISCUSSION

The chosen solution is composed by two different layers of insulators. The anti-seismic device is based on a pair of very low friction ball recirculation linear guides, aligned along two normal directions in the horizontal plane: in this way the seismic horizontal vibration transmitted to the statue is extremely reduced: allowing wide movements, at the same time, strongly reduces the forces reaching the statue. On the contrary the layer for mitigating the ambient vibrations is based on a set of rubber elements, with calibrated stiffness and damping, to generate a suspended mass and to reduce the vibration transmitted to the statue. Moreover, to prevent rocking, a metal element was glued under the bottom of the pedestal statue and connected with the base (to avoid any pins, which needed to perforate marble).

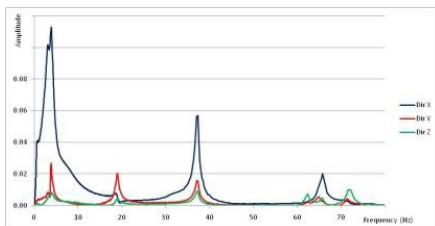


Figure 1 - (up) The statue on the multi axes shaking table for earthquake reproduction, the position of the sensors for vibration measurement and (bottom) an example of the magnitude of the frequency response function in the 3 directions.

The moving system protection system is made up of four vertical posts fixed to the cage base. This latter element blocks the statue base and two shaped jigs are mounted at different heights. This system allowed to lift and to move the statue as on a “tray”, without exerting any force on it. A monitoring system (500 Hz sampling frequency) with six accelerometers positioned on the cage and on the statue was used.

Prior the final installation, using a copy 1:1 made of Carrara marble, validation tests were performed to verify: the link between the statue and the base; the transportation and lifting system by monitoring shocks and vibrations; the placement of the statue on the new base; shaker tests to check the base under earthquake and ambient vibrations (Fig. 1).

### IV. CONCLUSION

This study, lasted two years, concerns the design of a single system for mitigating both seismic and environmental vibrations. Moreover, it was aimed at finding a technological solution, fitting two requirements: conservation and exhibition. The need to develop a project that relates both to valorization and conservation, required the collaboration of several institutions with different skills. The new museum of the Pietà Rondanini was inaugurated in the spring of 2015, after two years of studies and works (Fig. 2).



Figure 2 – The new museum of the Pietà Rondanini

The increase in the number of visitors and the received appreciation demonstrate that this difficult and daring decision, was the right one to be undertaken.

After two years, in April 2017, a first maintenance check on the mitigating vibrations system has been successfully carried out. The good results

achieved, allowed to fix the next check in three years.

In addition a 24/7 monitoring system continuously checks both the input produced by the trains (track maintenance can play a crucial role to define the input level) and the effectiveness of the base low pass filtering function (ageing of rubber elements may cause a worse vibration reduction).

In the end this project has allowed to lay down a methodological path as best practice for museum preventive conservation. The results can be extended to other cases, thanks to the systematic and precise documentation of all phases of the project.