L'AQUILA: A POST-EARTHQUAKE CARDBOARD CONCERT HALL

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1 INTRODUCTION

A powerful earthquake of magnitude 6.3 has struck the Italian town of L'Aquila on April 6th, 2009. Hundreds of lives were lost. Ten-thousand buildings were destroyed or seriously damaged and 58,000 people were left homeless.

Figure 1 Earthquake in L'Aquila

Assistance was provided and a tent city was erected. Today, businesses are still closed and most residents are unable to return to their homes.

Very early after the disaster, since L'Aquila is known as a "City of Music" and since the National Conservatory of Music had suffered serious damage from the earthquake, it was deemed important to provide music facilities.

The speedy construction of an easy-to-build and durable concert hall would provide momentum for the renewal of musical activities and provide some support to the victims of the disaster. It is significant to note that the Japanese Government led this initiative.

For the concert hall construction project, the Government of Japan has provided funds and has mandated Shigeru Ban, a Japanese architect specialized in "emergency architecture" and commins acoustics workshop to design the facility. The design work was performed on a voluntary basis by architects, engineers and construction companies, since the total budget was only around half a million euros.

The purpose of the present paper is to inform the acoustical community of the existence of this unusual concert hall and to invite acousticians to visit it and to evaluate the result.

2 AN UNUSUAL ARCHITECTURE

Shigeru Ban is known for his excellent projects experimenting with the use of cheap and recyclable materials such as cardboard or bamboo in response to emergencies arising from natural disasters. Through these cost-effective projects, Ban has been able to build dozens of buildings around the world in very poor areas affected by catastrophic events. He often collaborated with a network of volunteers.

Shigeru Ban has used paper components for emergency construction after disasters in Kobe, Turkey, Rwanda and Haiti and also for the Pompidou Center auditorium in Metz, France.

Figure 2 Paper house interior and exterior, paper log house, ceiling of Pompidou Center auditorium

3 FIRST SITE: REAL ESTATE DIFFICULTIES

A site was chosen: an old bus depot with a large roof on columns. The first sketches included the use of paper tube walls.

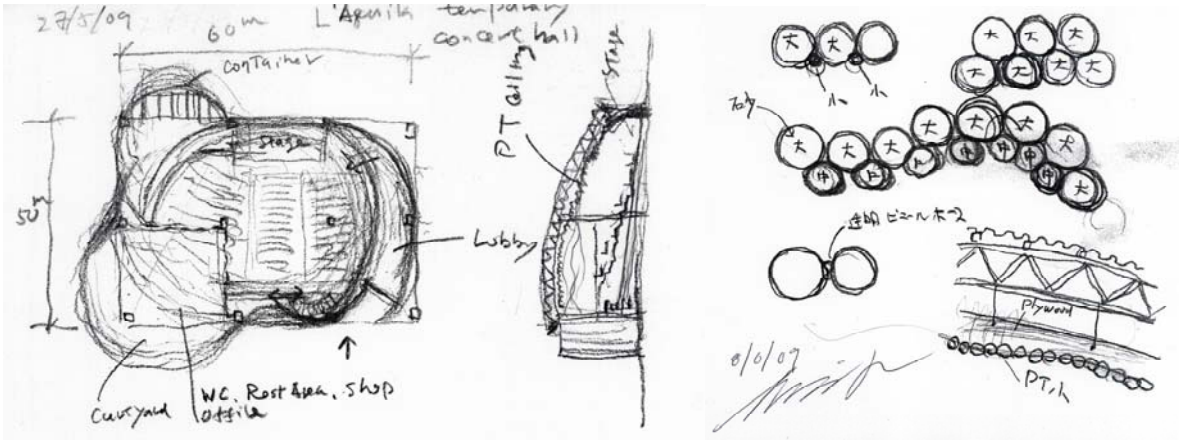

Figure 3 Early sketches for the first site

It then occurred that the facility was the property of a very powerful Italian organization and that negotiations were complicated; several years would be necessary to clear this up.

4 SECOND SITE: THE FINAL DESIGN

A safer site was picked and the same design principles were kept.

As it can happen, in spite of the arguments of the acoustician, the architect designed a quasi-elliptical hall inserted in a square 25-m x 25-m building covered by a lowered pyramid; the main hall houses theoretically 230-seats. The walls of the auditorium are made of heavy cardboard drums, recuperated from print paper rolls. A combination of diameters, 150-mm and 280-mm, wad used to create a diffusive wall that would be operational over the widest possible frequency range. The thickness of the drums contributes to the acoustical insulation but the tubes are also filled with sand; they are backed-up by thick sandbag walls that provide additional sound insulation.

Paper tube columns are also used as structural components. The other materials are more common: a wooden floor on sleepers and a triple-layered plasterboard ceiling.

The final design is a simplified version of earlier plans because of lack of funds. The elliptical shape was kept after studies showed that focusing effects would be moderated by diffusion from the walls and ceiling.

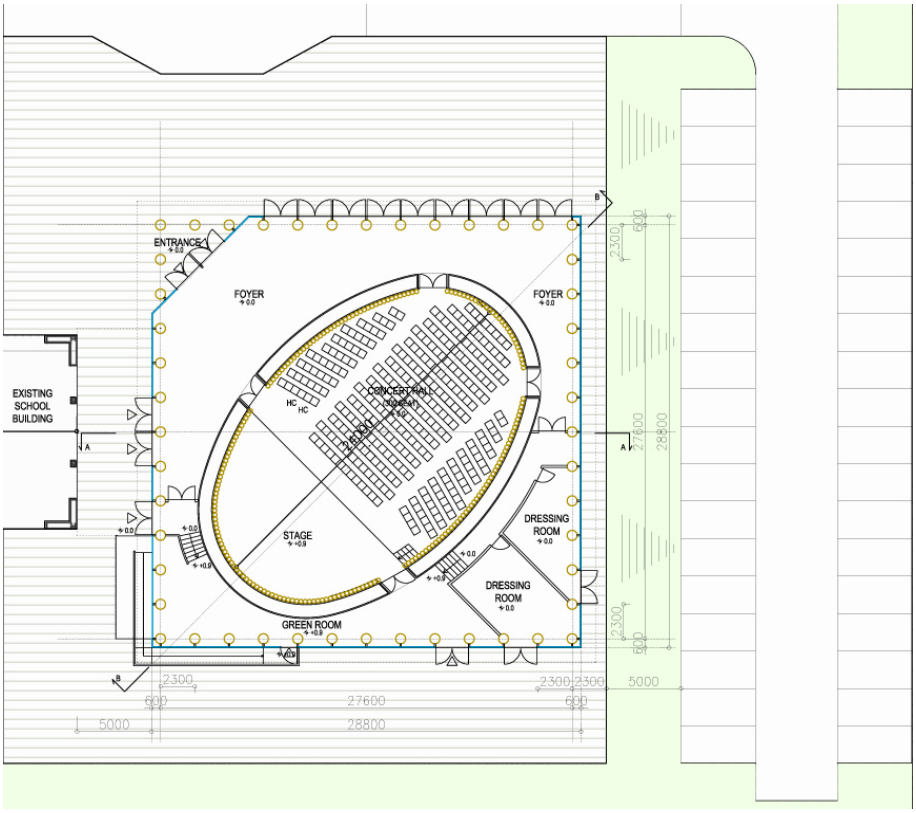

Figure 4 Plan of L'Aquila concert hall

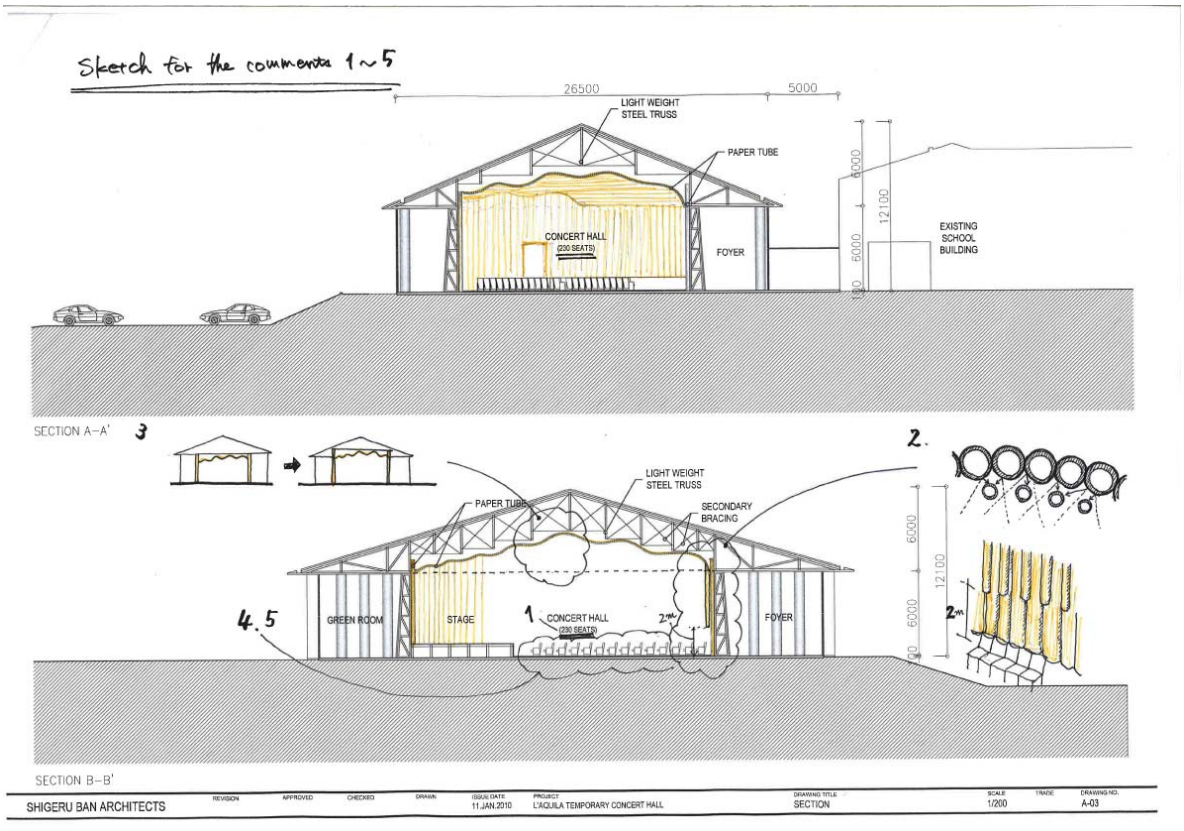

Figure 5 Transverse and longitudinal sections of L'Aquila concert hall

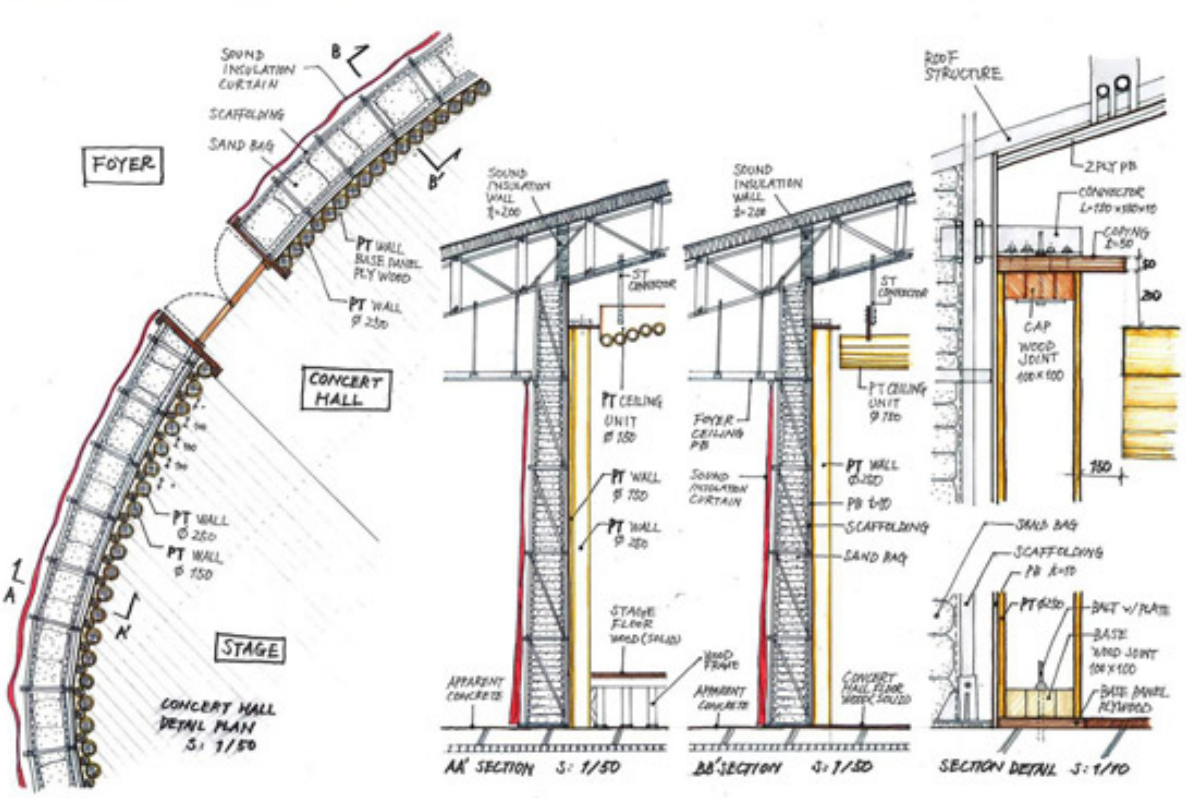

Figure 6 Study of construction details

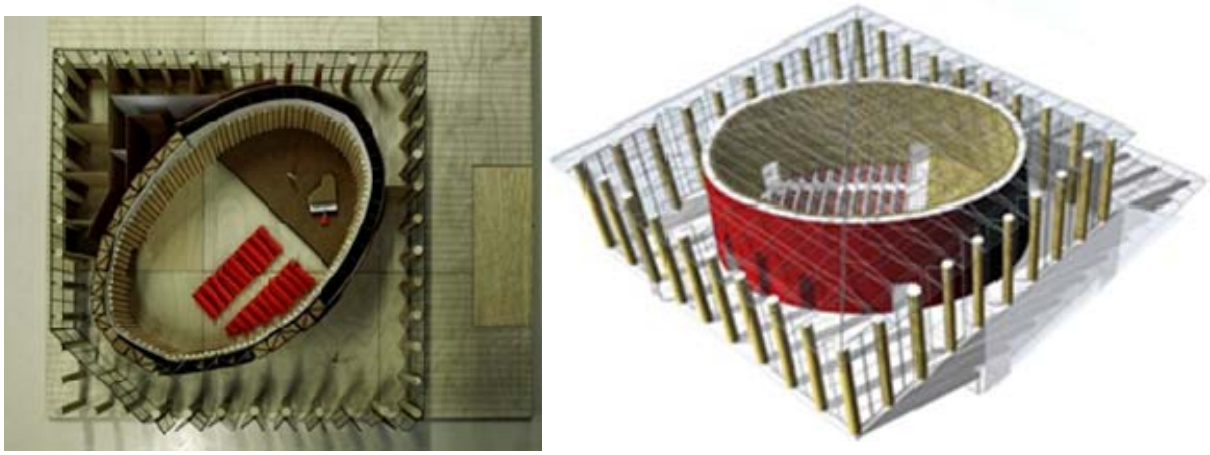

Figure 7 Views of models

5 LOW-COST CONSTRUCTION

During design and construction, the main goal was to keep costs at a minimum: most of the work was performed by volunteers and most materials were donated.

Of course, the building must meet all the regulations and safety requirements. This resulted in a lot of modifications which were not always compatible with good acoustics.

In December 2010, appeared an acoustical study by “Presidenzia del Consiglio dei Ministri: Dipartimento della Protezione Civile” which tried to demonstrate that large volumes are not necessary for concert halls since the “Decreto Ministeriale 18 dicembre 1975” which deals with school acoustical specifications allows for small volumes. It also concluded that a single plasterboard layer was sufficient for the ceiling and that a wooden floor on sleepers was not adequate.

It is not simple to reverse such decisions but, after long discussions and with assistance from the Japanese Ambassador in Rome and from the architects, the ceiling went back to its original position and thickness and the wooden floor was restored.

The following pictures illustrate construction phases.

Figure 8 Initial general structure

Figure 9 Sandbag walls

Figure 10: General views during construction

Figure 11 Structural paper tubes

Figure 12 Preparation of interior construction

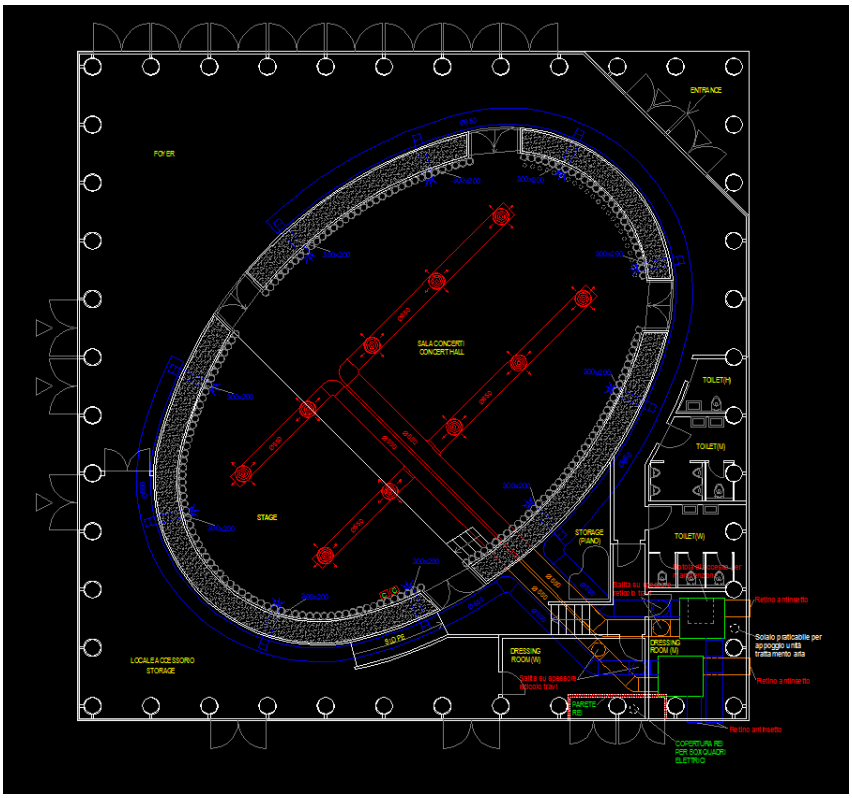

Figure 13 HVAC system

6. TARGET DATE

The input of authorities and of inexperienced consultants has delayed construction. Therefore no objective or subjective data is available.

Since construction may be completed in the spring of 2011, tests will be performed and the data will be published once the work is complete.

7. CONCLUSION

The project was a challenge for the acoustician because of the unusual technical and political context, because of the choice for the shape of the hall and of unusual materials.

Non-classical solutions had to be imagined to provide, at the lowest possible cost, good acoustics for music and a reasonable acoustic insulation.

If the result is good, this example may pave the way for low-cost concert halls of the future.