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Concrete versus gypsumboard : two techniques for a same objective

M. Asselineau
Peutz & Associates acoustical consultants
34 rue de Paradis, F75010 Paris, France

Abstract

The construction of large public venues such as cinemas and performance halls has been done for a long time using concrete walls. However, due to a quicker construction process and greater flexibility, gypsumboard walls are now frequently used for such venues, together with lighter structural elements.

Following a brief reminder of the usual acoustical objectives, and their translation in terms of wall construction, the concrete construction scheme is compared to the lighter gypsumboard construction. While this comparison is mainly centred on the acoustical performances, some side aspects (such as cost, speed, and safety) are also considered.

One of the main conclusions is that while gypsumboard construction can help complete a project faster than concrete construction, it requires from the workers a degree of skill that is not often to be found with the average contractor.

1. Introduction

The construction of large public venues such as cinemas and performance halls calls for rather high sound insulation objectives between the hall and the other rooms inside the building, and also between the hall and its outside environment. For example, a sound insulation objective of 65 dB in terms of D_w extended on the 50 to 5000 Hz range can be sought between halls, with a 55 dB sought between hall and outside environment.

For many years, the envelope of the halls has been built using concrete walls, with a thickness easily reaching 30 cm and over between halls. Those walls simultaneously acted as structural elements and envelope.

However, using concrete in the construction process meant that a significant time was lost for the drying up of the construction. Furthermore, once the hall was built one could not easily think of refitting the building by changing its general dimensions. This prompted the designers to try and use alternate techniques.

2. A few acoustical parameters to be considered

Both simple and double wall constructions are quite well known as far as their acoustical performances are concerned [1]. A typical massive wall (concrete construction) sound insulation performance typically depends on its mass, and basically the heavier the better. Usually, the mass value will be set according to the minimal performance required in the low

frequency range, while checking that the 6 dB per octave rate of climb of the insulation curve will manage to comply with the acoustical requirements of the project. A typical double wall (gypsumboard construction) sound insulation performance typically depends on both the mass of the walls and the thickness of the gap between them ; in addition, the connections between both walls have to be taken into account. Once again, those parameters will be set according to the minimal performance required in the low frequency range, and usually the 12 dB per octave rate of climb of the insulation curve proves sufficient to cope with acoustical requirements. It must be stressed out that attempting to set the acoustical parameters of the wall on the sole basis of its performance in the mid frequency range will usually lead to unsatisfactory performances in the low frequency range.

3. Concrete and gypsumboard construction

A typical concrete construction would, for example, call for a 30 cm thick concrete wall between halls, with a 20 to 25 cm thick concrete wall on the corridors. In addition, a 20 to 25 cm thick concrete wall would be used on the outside environment ; this wall has to be treated to a thermal insulation, which cannot be used as absorptive treatment inside the hall due to its waterproof membrane, and that must be applied only when the wall construction has been fully dried. More to the point, care must be taken that this insulation does not decrease the sound insulation performances of the wall. The erection of such high walls can prove quite a complicated task, as several casting frames have to be used over the important height (often greater than 8 m), that have to be handled using the crane. More to the point, those frames are assembled by means of fasteners that leave a hole in the wall when the casting frame is removed; those holes have to be individually closed using a concrete plug. A typical wall construction would call for an average 8 days duration for a 8 m high and 20 m long wall due to the handling and drying time required. In addition, those construction activities are slowed down or even halted if the weather does not cooperate.

A typical gypsumboard construction would nevertheless call for concrete floors and either concrete or metal roofs, with steel structural elements. The partitions would, for example, call for a 45 cm minimum thick wall between halls, with a 25 to 30 cm thick wall on the corridors. The building structure is usually hidden inside the partitions. Such partitions would feature, for example, 2 to 4 gypsumboard plates on each side of the wall, with mineral wool in between. Due to the important height of the wall (often greater than 8 m), the safety regulations require a maximum deflection value for each side of the wall under given strain conditions; depending on the manufacturer and contractor in charge, this can be achieved through the use of either resilient connectors between each side of the wall [2], or heavy rigid frames [3,4] that satisfy the requirements. Another solution calls for the gypsumboard plates to be mounted on steel panels filled with mineral wool, that are resiliently attached to the structure of the building [5]. The decoupling of the wall sides that is so desperately sought by the acoustical engineer must be checked with care, as quite a number of contractors tend to ignore this rule and seem to be bent on jamming every possible object (from bundle of cables or ducts to waste materials) inside the wall (it must be stressed out that those high performance gypsumboard partitions do call for skilled labour, especially in case of tall partitions). In addition, a 25 to 30 cm thick composite wall (gypsumboard on the inside, metal or wood panels on the outside) would be used on the outside environment. As the wool inside the partition can be used as a thermal insulation, no specific thermal treatment has to be devised inside the hall. Unless heavy frame assemblies are used, no specific hoisting system has to be used (but scaffolding will be needed along the partition). A typical wall construction would call for an average 5 days duration for a 8 m high and 20 m long partition mainly due to the handling time required. The gypsumboard construction would typically start as soon as the roof of the first hall is completed. However, care must be taken with regards to the protection from the weather.

4. Comparing concrete and gypsumboard construction

The comparison between the two construction methods does not solely rely on the acoustical performances. Here are a few points worth noting.

4.1 Acoustical performance

The sound reduction performances of both construction methods can comply with the required acoustical objectives. However, due to the rate of climb of the sound insulation curve, the gypsumboard construction usually provides a better acoustical comfort due to its higher performance in the medium and high frequency range.

4.2 Time

With the concrete construction method, time has to be allocated for the drying of the walls and the plugging of the holes ; more to the point, the handling of the cast frames calls for the crane, which is not available for other purposes during this task. On the other hand, the gypsumboard construction does not call for any specific handling, save for bringing in the pallets of plates, and does not require drying time. The gypsumboard construction is usually faster than the concrete construction.

If the design features a flat floor, then an automotive platform can be used to great advantage to perform work along the partition. However, such a trick is not possible with a stepped floor and it then is necessary to erect a full scaffold along the partition.

4.3 Cost

At the date of writing, the cost of a gypsumboard construction can be 15% over that of a concrete construction.

4.4 Flexibility

Should any change be needed after construction, it is not difficult to tear down a gypsumboard partition and make a new one at a different location. On the other hand, concrete partitions are usually near to impossible to tear down as they usually provide a structural support of the building. This makes the gypsumboard construction particularly attractive to the final users.

During the construction process, holes in a gypsumboard partition are pretty easy to make. This is a benefit should a duct or a cable be forgotten during the design phase, but it also means that workers will usually not hesitate to tear open the walls for any reason (which is not the case with the concrete construction, as drilling a hole is no small task). Therefore, one must be vigilant till the wall covering is fully implemented.

4.5 Structure

The gypsumboard construction is of course lighter than the concrete construction. This can be a help when structural considerations lead to a weight reduction of the building (e.g. in case of a seismic environment).

However, with gypsumboard construction care has to be applied regarding the suspension of heavy pieces of equipment (e.g. lighting, loudspeakers) for which a specific supporting structure may be needed.

4.6 Miscellaneous

Depending on the local site conditions (e.g. presence of water near the ground, or steep terrain) a concrete lower wall may prove to be necessary. Under those conditions it is sometimes more economical for most of the project to be made of concrete elements.

Care must be applied to avoid the intrusion of water in a gypsumboard construction. Unfortunately in a typical construction scheme there are only a few meters of roof preceding the partitions. Whenever no proper care is applied with regards to the water proofing of the building, trouble can occur, with its consequent need to replace parts of the partitions and ceilings.

An unknown quantity might be the perennity of the gypsumboard construction: what if the mineral wool fasteners let go?

Conclusions

Should one go for a gypsumboard or concrete construction? There is no definite answer. While gypsumboard construction is speedier than a concrete job, the later is sturdier and more within the trends of habits of the building world. The costs of both construction methods are pretty similar. Eventually, the gypsumboard construction offers more flexibility should any change occur inside the building. The final choice can only be taken after careful examination of the positive and negative aspects (e.g. duration, weight and dimensions restrictions, etc.) within the specific project under consideration, including the availability of skilled contractors.

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