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NOISE CONTROL PROJECTS: THE EUROPEAN EXPERIENCE

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Abstract

Various European Directives have been drafted over the years in order to œope with such problems as occupational noise, community noise control, urban noise, and environmental noise. The implementation of those directives is usually done by means of the national legislations but also through the European standards. The problem often is to issue a text that is compatible with each local custom (e.g. the “evening” can be quite a different period for a Dutch or for a Spaniard!). Therefore some interpretation can sometimes be needed and it is not uncommon for a foreign company seeking to open new premises to ask for clarification and advice to a consulting engineer. This paper submits an overview of some national regulations based on European directives and relevant standards. It is illustrated using case studies on façade insulation near transportation corridors, community noise, building noise control and occupational noise.

1. INTRODUCTION

The European Union is a quite complicated place, with the multiplicity of languages and dialects spoken being only the visible part of the iceberg! When it comes to legal texts, the difference in local culture and habits can account for significantly different approaches to the problem.

How different those approaches are can be assessed when looking, e.g., at the French and German requirements regarding the construction of subsidised dwellings: while the former first perform an analysis of the drawings before committing part of the funding, and then only relinquish the remainder once the commissioning measurements have been performed, the later merely look at the drawings for execution will of course be in compliance with those drawings

This paper submits a brief overview (it certainly does not claim to be exhaustive) of some national regulations based on European directives and relevant standards, as nowadays they are constantly referred to for the technical aspects of regulations. It is illustrated using case studies on façade insulation near transportation corridors, community noise, building noise control and occupational noise.

2. COMMUNITY NOISE CONTROL

Community noise is one interesting subject when looking into the specificities of the European culture. For what is considered late evening for a Dutchman will merely be the end of the day for a Spaniard! So while the L_{den} equivalent level is used throughout the European Union, the corresponding hours can be significantly different. Furthermore, what would be considered a major inconvenience in a northerly country is merely considered as the noise of life in southern ones!

In France community noise control has been performed through the notion of emergence, i.e. the gap between the ambient noise level (measured during the appearance of the particular noise under scrutiny) and the residual noise level (i.e. the background noise level measured without that noise). Over the years, the law text has evolved from the A weighted approach using the equivalent sound levels [1] to a more complex one taking into account octave bands when dealing with dwellings [2]. While in 1988 there only was a general law text, theoretically applicable to various situations, it was ill suited to musical noise due to its tonal character and large dynamics. So, in 1998 a new law text was introduced regarding the musical facilities: in such a case the emergence was now investigated in octave bands; this meant that from now on the notion of tonality was partially taken into account (one might care to note that while everybody acknowledged that the low frequency content, i.e. the 63 Hz octave band and lower, was particularly annoying, it was not deemed reasonable to try and measure such sound levels inside a small room). More to the point, the application guide actually suggested that while the predictive musical sound levels (or the measured ones for that matter) should be assessed in terms of $L_{10\%}$, the background noise levels should be assessed in terms of $L_{90\%}$.

In Belgium it was deemed much more expedient to reduce the musical sound levels inside the facility, and the relevant law text [3] simply limited the sound levels to 85 dB(A) on the dance floor. While this more or less ensured that the neighbourhood was not unduly annoyed, it also helped protect the hearing of both spectators and workers of the facility. Meanwhile in Scotland the police had the power to decide whether a noise was annoying or not simply based on their hearing it or not! As concerns Germany, the relevant standard [4] does emphasise the notion of tonal noise.

Of course the evolution of the law text did have some consequences. One actually witnessed in the early 1990s a heavy refurbishment project of a skating and swimming facility in which both the background noise levels and the predictive musical sound levels were assessed using the Leq; unfortunately for the end user when the work did start in earnest the new legislation now did request the background noise levels to be assessed as L90% and the predictive musical sound levels as L10%, which lead to an improvement of 10 dB of the targeted sound insulation of the envelope of the building and a very sizable increase in the cost of the construction too.

The differences between national legislations and habits could also lead to somewhat surprising results. There once was an interesting case of an Irish owner renting a shop at ground floor of a house in downtown Paris in order to build an Irish pub: he was genuinely surprised that such petty matters as sound insulation requirements between a shop and the nearby dwellings, as well as noise control measures, were actually mandatory!

Regarding industrial premises, in France while the former usual law text had initially made extensive use of the equivalent sound levels [5], the new law text [6] can actually also use the $L_{50\%}$ according to whether the gap between the L_{eq} and the $L_{50\%}$ is greater than 5 dB(A) or not. This move was made in order to try and protect the environment in cases where there is a nearby road with only a couple of vehicles going by.

This one text actually is a frequent source of misunderstanding, for while it does consider the sound levels over the whole day or the night periods, in case of claims the

judicial expert will typically perform his measurements over a half hour period as suggested in French standard S31.010 [7]. It is not uncommon for foreign consulting engineers and end users to complain about the fact that while there are rather high sound level values in terms of L_{eq} (e.g. because of a nearby road with intermittent traffic) the local requirements call for rather stringent specifications based on the $L_{50\%}$ value, with significant financial consequences. One did see an interesting case of a port facility complete with handling systems designed by Dutch engineers that would have been perfectly suited to the Dutch regulations but did not comply with the French requirements.

3. BUILDING NOISE CONTROL

The acoustical performances of buildings, whether for dwelling purposes or for social uses, have been the subject of quite a few papers [8]. There typically are requirements for the sound insulation of dwellings with regards to other dwellings or other spaces within the same building. In addition, there are requirements regarding the sound insulation of dwellings with regards to the external environment; lastly there are requirements regarding the background noise levels generated by the mechanical appliances inside the dwelling and its building.

In France the quest for acoustical comfort within acceptable financial limits has driven the typical requirements for sound insulation between dwellings from 50 dB in 1969 [9] to 53 dB in 1999 [10], while the sound insulation between a dwelling and a commercial facility (e.g. a shop) has similarly jumped from 55 dB to 58 dB; typical background noise requirements inside a bedroom or living room are 30 dB(A) for building appliances and 35 dB(A) for the dwelling own appliances. In addition, there are requirements regarding the sound insulation to the external environment [11] that will be covered in the next chapter.

Other European countries also have similar requirements, with the sound insulation between dwellings a typical 53 dB in terms of $D_{nTw}+C$ [8].

When better housing is being looked for, there are some schemes for increased quality (e.g. the owner will be allowed by law to ask for a higher rent). In France there is a certification procedure known as Qualitel, in which the owner will first submit his drawings to a certified organism that will check whether the predictive acoustical performance will comply with the requirements [12]. Satisfying those requirements (namely making sure that the results will be better than the legal target by at least 3 dB) will allow the project to proceed till commissioning and part of the funding to be delivered. At last successful commissioning will allow the remainder of the funding to be delivered. In Germany, there is a similar system but allowing for German's respect of law and order the moment the drawings are cleared the whole funding is deliverable.

Those regulations are of course applicable to new housing; older housing is not subjected to these regulations (safe for the insulation with regards to the external environment which will be discussed in the next chapter). However, there is a growing trend to consider that whenever work is carried out on an existing building, the eventual acoustical result must not be worse than the previous performance. For example, removing an old carpet covering and replacing it with tiles will be considered by judicial experts to be a potentially bad move irrelevant of whether the legal targets are still being complied with or not [13]. One has witnessed situations in which the judge ordered a builder to put back a carpet in place of tiles even when the proper precautions had been taken to mount those tiles on a screed with a resilient sub-layer. Incidentally, a particularly unpopular move is to shuffle the various types of rooms inside the building (e.g. replacing a bedroom upstairs by a kitchen or a bathroom).

One should note that the various aspects of the legislation we are talking about do not exclude each other. In that respect the background noise level issues can be quite a problem. One remembers an interesting case [13] in which a surpressor located inside a small courtyard

of a dwelling generated noise levels of 28 dB(A) inside the bedrooms, which was well under the legal target of 30 dB(A) defined by building regulations. However, the judge ruled that with a background noise level as low as 21 dB(A) the emergence was well over the 3 dB(A) mark and therefore this noise was potentially annoying and the construction defective.

With the gradual introduction of European standards, local specificities regarding the assessment of the acoustical performances of buildings are gradually phase out. For example, the French standard S31.057 [14] that described the measurement of acoustical performances of buildings has now largely been replaced by European standards such as EN ISO 10052 [15]. This means that nowadays any European noise control engineer can easily perform commissioning measurements anywhere in Europe, or at least prepare the schedule for those measurements to be performed locally.

Strong standardization work [16] has also lead to prediction methods usable throughout Europe [17]. Those methods are quite useful in enabling noise control engineers to try and assess the predictive acoustical performances of a construction using the available acoustical test reports (that is, unfortunately, those that have been entered inside the computer model). More to the point, due to the standardization of the method, it now is possible for noise control engineers of different nationalities to discuss easily the acoustical consequences of various options in the construction.

4. TRANSPORTATION NOISE CONTROL

With such a densely populated area as the European Union, significant transportation noise levels are to be expected in the environment. The assessment (for future planning and eventual remediation) of the noise levels in the urban environment due to transportation corridor noise has been the target of a European Directive [18].

Two cases are mainly considered: road and rail traffic noise, and air traffic. The former is of course ubiquitous, with housing usually not far away. While the latter usually is further away (with law texts preventing the appearance of dwellings too close to the airport facility), the flight paths usually cover vast expanses of land which are quite often located in densely populated areas.

Road traffic noise has been well known for years in Europe: One can already find texts from Roman authors complaining of the din made by horses and carts inside the cities, to the extent that some emperors had prohibited the use of such transportation in some areas during circus performance [19]! Nowadays traffic noise has been the subject of numerous papers. The targets as defined by the European Directive are expressed in terms of A-weighted equivalent sound levels over the day period and the night period, with the aim of not exceeding 65 dB(A) in night time and 70 dB(A) in day time. Should those values be exceeded when creating a new road or increasing the flow rate of vehicles, noise control provisions (e.g. noise barriers, special road covering surfaces) must be implemented. Should that fail too, specific measures must be implemented in order to increase the sound insulation of the exposed facades.

More to the point, provisions have been devised in order to cope with an eventual increase of traffic: in such a case, should the Leq be increased by more than 2 dB(A), noise reduction measures must be applied [20].

In France, road and rail traffic noise had been subjected to a law text [21] that relied on a classification of the transport corridor under scrutiny, which was performed by the local authorities, to decide on the required level of façade insulation depending on the distance to the nearest lane or track. This definitely meant that whenever that transport corridor was not classified no façade insulation target was requested. This sometimes lead to funny situations (for the observer that is…): for example while the ring around Paris did have a classification

for the surrounding suburbs it did not feature such a classification for the Paris township, which meant that newly built suburban dwellings were actually theoretically to be better insulated than similar dwellings on Parisian ground! But there could be even worse: in a spectacular case an important motorway was built between the towns of Lyon and Grenoble; when it was found that the façade sound insulation of an old farm housing elderly people and students was to be significantly increased, the local authorities first balked at financing such an improvement for all the rooms and then simply eased themselves out by declassifying the stretch of motorway running in front of the farm! However, as shown in another similar case in which elderly people suddenly found themselves uncomfortably close to a new motorway, the Court eventually awards compensation in such matters [22].

In Netherlands the requirements regarding façade sound insulation are defined based on the notion of background noise levels inside bedrooms and living rooms [23]. This means that an acoustical study is requested for most of the constructions and a special calculation method has been developed for those matters [24].

Regarding air transport noise, in France the regulations have been based on a classification of the land areas according to noise exposure. The quantity initially used was the so-called "isopsophic index" [25] which was an equivalent sound level in which the contribution of night flights was taken into account with an aggravating factor of 10. Nowadays, the regulations use the Lden throughout Europe [26]. Basically, the regulations call for dwellings to be forbidden in the inner noise zone safe for essential constructions for the airport facility (and then of course with severe requirements on the façade insulation); they also call for new construction to be rejected in the middle noise zone (while serious improvements must be carried out in the existing houses that are eventually kept), and for severe limitations regarding the outer noise zone.

5. OCCUPATIONAL NOISE CONTROL

While occupational noise control is quite strongly called for, its implementation is significantly different in the various countries of the European Union. The Directive issued in 2003 [27] states that the daily sound exposure level $L_{Ex,d}$ should not exceed 87 dB(A) with hearing protections on, while the warning and danger thresholds (as assessed without hearing protectors) are respectively 80 and 85 dB(A). The basic idea is that should the $L_{Ex,d}$ reach the warning mark the employer must warn the workers and provide them with individual protectors; should the $L_{Ex,d}$ reach the danger mark the employer must enforce the wearing of protectors and implement a noise reduction plan. Measuring the sound exposure level of workers is mandatory whenever they are likable to be exposed to such levels. Lastly, it has been specified as soon as 1988 in another Directive [28] that the employer is requested to reduce noise to its lowest reasonably possible level according to the state of technics.

While those objectives are clearly stated for the whole of the European Union, the way to measure them is not, as the methodology is defined by the relevant national standards [29, 30, 31]. However, several countries are now teeming up to try and draft a European standard out of the brand new ISO 9612 standard under elaboration [32]. Basically, the idea is first of all to try and analyse the work pattern inside the facility, then to divide the population under scrutiny into homogeneous exposure groups into which several individuals will be selected for measurement under representative conditions.

This actually is where it hurts, as while so-called representative conditions are quite easy to define when dealing with mass production line workers, it really is a bit more complicated when facing maintenance workers whose tasks are often unpredictable. This means that apart from taking a rather long time to gather the necessary data and perform a work analysis so as to define the applicable methodology, significant hours will have to be

spent on measurements proper.

How is this done throughout the Union? Well, French laws do enable the labour inspector to order an industrial to perform noise exposure measurements. Good news, failing to do so is liable to a fine; now for bad news the value of this fine is considerably less than the actual amount needed to pay for a measurement campaign… As regards Great Britain, the idea of HSE is to incitate people to use their money in actual noise control rather than in measurements!

Another aspect of occupational noise is the way the building has been subjected to noise absorbing treatments. In France there is a law text [33] applicable to new or refitted workshops which requests the spatial sound level decrease to be assessed and that requires a minimal value should the noise exposure at workstations be greater than 85 dB(A). Well, the loophole is quite clear for everybody to see: the builder usually does not know whether the noise exposure levels will really be 85 dB(A) or greater, while the operator will usually argue that the building he got for the purpose of his activities had not been outfitted with such precautions beforehand. The concept of spatial sound level decrease has latter on been developed in a European measurement standard [34].

6. POSSIBLE EVOLUTIONS

As initially drafted, the European regulations, that is, the national regulations used throughout European countries, mainly relied on the A weighted equivalent sound levels or even on the A weighted sound levels measured using the Slow characteristic. The basic idea behind the use of such a simple descriptor was to enable easy and frequent measurements to be carried out, especially in building acoustics.

Over the years, the evolution of the measuring equipment has made more complicated measurements readily feasible. This allowed statistical measurements to be used in order to qualify the acoustical environment. More to the point, this has also allowed more and more spectral measurements to be carried out. Nowadays it is quite usual to try and assess the potential risk of annoyance through the eventual presence of either tonal components or simply too significant a frequency band. Some regulations are already looking forward to use the C weighting or the road traffic noise spectrum for other purposes.

As an example of such evolution, let us consider the assessment of the acoustical characteristics of dwellings. Initially, the French standard S31.057 [14] gave a methodology to assess the acoustical performances of buildings through rather simple means, e.g. the sound levels generated by lifts was measured in one point in the room using the slow characteristic of the sound level meter. Nowadays, using the European standard EN ISO 10052 [15] three measurement points are needed. This means that while the measurement results are more and more precise, the time needed to perform and analyse the measurements is growing longer and longer, even with the assistance of evolved sound level meters [35].

An interesting case will be that of musical venues, as their staff is supposed to comply with the occupational noise regulations too.

The years to come will probably see more unified regulations referring to European standards, with better precision in the measurement results but more time consuming, especially as each nation has tried to keep a sizable part of its former customs and habits inside those standards.

7. CONCLUSIONS

The European Union is a quite complicated place, with the multiplicity of languages and

dialects spoken being only the visible part of the iceberg! When it comes to legal texts, differences in local culture and habits can account for significant differences.

Acoustics does not escape this trend. This accounts for quite different ways of tackling the noise reduction problems. While there has been a steady move to European standards so as to enable different actors from all over Europe to understand each other, the real act is performed by means of regulations. The latter do reflect the local specificities, e.g. the limits of evening time vary significantly from Spain to Denmark! Also, some behavioural trends can be observed, e.g., for the construction of subsidised dwellings: while the French first perform an analysis of the drawings before committing part of the funding, and then only relinquish the remainder once the commissioning measurements have been performed, the later merely look at the drawings for execution will of course be in compliance with those drawings.

An overview of some national regulations based on European directives and relevant standards has been submitted in this paper. The latter are nowadays constantly referred to for the technical aspects of regulations. Developments are expected in the next years especially regarding such aspects as occupational noise control and community noise control.

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