NOISE POLLUTION IN A GENERAL HOSPITAL

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1. INTRODUCTION

Noise is a known environmental pollutant and health hazard. Particularly, noise pollution in a general hospital (ex: operating room, recovery room and intensive care unit) is a hazard to surgeons, anesthetists, personnel and patients. It is well documented that noise is stressful, eliciting changes in the autonomic nervous system, impairing mental faculties and producing masking that could affect the staff and the conscious patient alike, leading to decreased work performance and increased anxiety respectively. Moreover, operating room noise can reduce the mental efficiency and short-term memory of anesthesia residents. Therefore noise prevention needs more attention and should be a routine part of patient care.

The design of a modern General Hospital should consider acoustics as one of the main factors to provide comfort to both patients and medical staff. The acoustic environment is determined by the atmosphere of the site (external noise) as well as by the performance of elements as room dimension and destination, construction materials, surfaces and furnishings. Every possible item of sound transmission must be considered from the designer and every possible way of noise impact reduction have to be adopted. The acoustic requirements of doors, walls and ceiling constructions must be calculated and their resulting values can be used to check and correct the presence of unwanted noise. Consideration also needs to be given to the impact of internal services such as plumbing, electrical and mechanical plants and distribution systems like air-conditioning as well as external noise generated by linear sources (road and rail traffic noise) or other point sources in the area.

The paper refers to case studies carried out in some General Hospitals in Tuscany (Italy). In figure 1 the brand new Versilia General Hospital is represented.

2. METHOD

The methodological approach to estimate acoustic atmosphere and acoustic comfort in internal hospital areas have been studied. Noise pollution and sound impact of machines, activities, traffic and other sources have been considered by adapting algorithms and rules provided for in the specific ISO concerning emission and attenuation of noise. Starting from information about territory and structure of buildings, a study of the noise atmosphere has been carried out in a context represented by various different types and compositions of sources and receivers. The structure of buildings and the related characteristics of sound propagation in the hospital areas and outdoors are analyzed using the ISO methods and models concerning the acoustic properties of buildings.

The chosen method of acoustic analysis considered building and activities as sources of noise as well as noise receivers. Starting from the acoustic climate "ante operam", the study has been performed according to the following program:

- acoustic analysis of inner and external sources;
- measurement and computation of the acoustic impact on the inner and external receivers;
- analysis of acoustic requirement of the building..

Noise impact of the new building on the acoustic atmosphere of the surrounding receivers has been tested and analyzed. Italian City Administrators ask for noise impact prediction, as a necessary preliminary document, to authorize every potentially pollutant activity, as a new general hospital can be.

Measurements of the residual level have been carried out in emplacements homogeneously distributed along the perimeter and in the building area, privileging the directions of propagation from the more meaningful sources towards the closer receivers (see fig. 1).

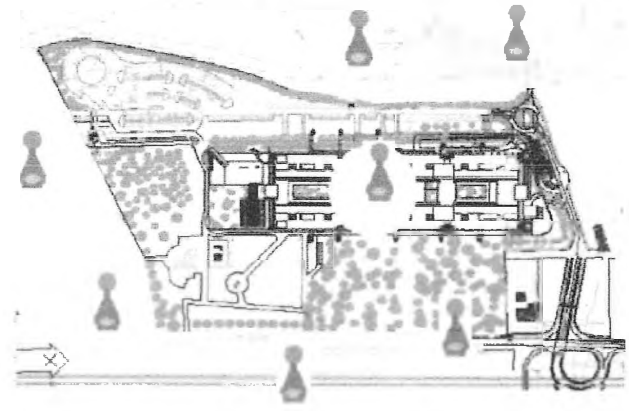

Fig. 1. The new Versilia General Hospital in Tuscany (Italy)

The considered International Standard references are ISO 8297 for the determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment, ISO 9613-2 for the method of calculation of the attenuation of sound during propagation outdoors and the standard acoustic tests for the conditioning and ventilating systems an plants.

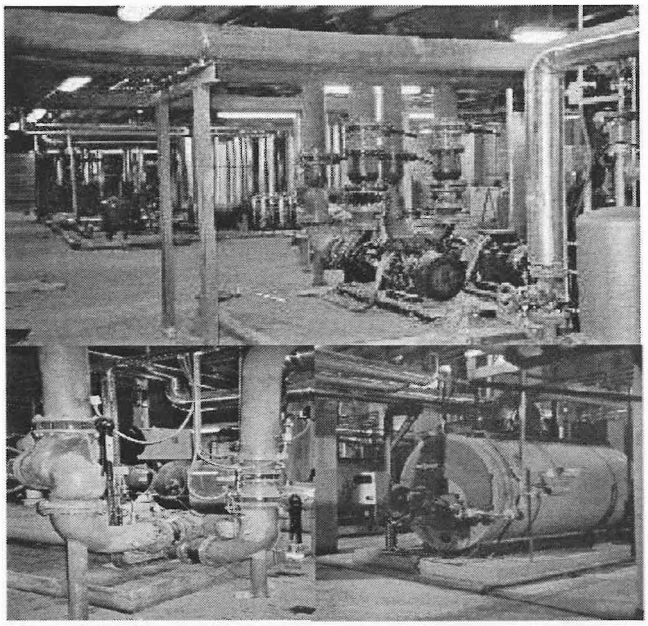

Fig.2. Internal sources

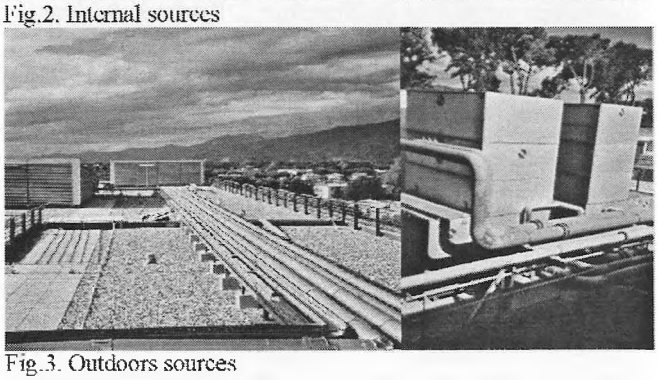

Fig.3. Outdoors sources

In the new Versilia General Hospital the system of sources occupies the building area, the roof and a portion of the surrounding area in a territory that is principally destined for rural use, although a motorway and a high traffic national road stand in proximity of it.

The analysis of the acoustic quality of the building has been performed measuring and calculating all the significant parameters, such as R_w, $L_{n,w}$, $D_{2m,nT,w}$ as defined by the standard ISO, and remembering that the effects of noise on people depend primarily on the duration and timing of the sounds. Each Operating room received special consideration as one of the sensitive areas. Sometimes the flat, water impermeable walls of the modern operating room are outstanding reflecting surfaces for sounds. Noise levels in the operating room can easily approach those from a diesel engine. Loud sounds have been shown to contribute to stress as measured by responses of the pituitary-adrenal axis. In addition to affecting health care workers, the din of the operating room and other acute care areas can be disconcerting to conscious patients. Although noise is known to cause problems other than hearing loss, it appears prudent to limit unnecessary sources in the operating room.

parameter	room 1	room 2	room 3
R_W	41.5	44.5	34.0
$D_{2m,nT,w}$	30.0	21.5	21.5
$L_{n,w}$	59,0	58,0	58,5

Table 1. Acoustic Quality parameters for three different operating rooms, measured and calculated according to standard ISO rules

3. RESULTS

This method brings to a view of the acoustic performance of a General Hospital, considering the sources and the receivers of noise inside and outside the building.

Various applications of the method have generated and tested a strategy for determining the suitability of an urban or rural area to accommodate a General Hospital.

The study of the systems generating noise pollution, represented by different types and compositions of sources has been performed and the frequency characterization of the emissions has been analyzed. The structure of the buildings and the related characteristics of sound propagation towards the sensitive receivers outdoors have been studied. The acoustic separation and insulation between adjacent rooms or areas have been tested as well as the avoidance of cross-talk via duct work between adjacent rooms. The design of systems and plants had to be changed to minimize air-conditioning and plumbing noise, the design of the internal areas must consider the need of adequate privacy for areas such as bathrooms and the need of acoustic quality in rooms where speech intelligibility is very important, such as consulting rooms or other areas where to ensure patient confidentiality. Finally the design of the perimetrical walls must consider the air borne and structure borne propagation generated by traffic and point sources and transmitted by the structure itself..

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