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Field study of the indoor environment in a Danish prison

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ABSTRACT

The indoor environment in a Danish prison was evaluated based on measurements made during the summer season of temperature, relative humidity and carbon dioxide, as well as through carefully conducted surveys among the inmates. The temperatures in the cells were high and well beyond common levels in Danish buildings. The mean CO_2 concentrations were generally low, but reached high maximum levels up to 5000 ppm. Thirty-one inmates responded to the questionnaire. They spent on average 19 h in the cell per day (range 12–23 h). Sixty-nine percent of the inmates expressed dissatisfaction with their general indoor environment and all responding inmates expressed dissatisfaction with the thermal climate. Dissatisfaction was mostly caused by a lack of airflow and air movement in the space as well as excessive direct sunlight from the windows. Security is a leading factor in the design of prisons, so a compromise must be found to ensure that the building can comply with minimum health and comfort standards. The findings of this study can be used as background for recommendations for renovation of prison buildings.

1. Introduction

For long, prisons have been seen as a way to punish offenders and keep them away from the society. However, beyond the punishment the inmates have the right to minimal standards of living conditions, according to rule 18.1 of the Recommendation Rec(2006)2 of the Committee of Ministers to member states on the European Prison Rules [9]:

> "The accommodation provided for prisoners, and in particular all sleeping accommodation, shall respect human dignity and, as far as possible, privacy, and meet the requirements of health and hygiene, due regard being paid to climatic conditions and especially to floor space, cubic content of air, lighting, heating and ventilation".

Commonly used European and Danish standards (e.g. Refs. [6,7]) do not have any design criteria for the indoor environment in prisons, as opposed to what is the case for educational or office buildings. This is in stark contrast to the fact that prisons are expected to provide a multiplicity of functions and often is categorized as a place for extended occupancy; as [16] wrote, "prisons are schools, hostels, places of worship, factories and hospitals rolled together".

The building design and services field has integrated the importance of creating liveable spaces that enhance well-being for their occupants with the need of reducing the environmental impact of constructions. Moore (1981 cited in Refs. [11, p. 15]) studied a correctional facility in Michigan, USA and demonstrated that detainees whose windows faced the prison yard visited the health care facilities more often than inmates whose windows faced natural scenery. This health topic is particularly important for inmates' health conditions, where lack of freedom and privacy and overcrowding already impact their health and behaviour [19]. A good indoor environment is also important for prison employees who sometimes work in stressful or violent situations.

While the literature on indoor environment in prisons is limited, the positive effects of adequate building design have been widely studied and recognized in the health care sector [23]. If it is considered that, beyond the deprivation of freedom, the role of prisons is to take "care" of offenders – regarding their social behaviour or addictions for instance, these observations may justify using an approach for prisons that is similar to the one used in the health care sector. As a result, new prison designs have emerged as an alternative to merely functional buildings, with the most cited example being Halden prison in Norway [1].

However, in older and conventional prisons inmates may experience more severe exposures from the indoor environment. In

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their field study in an overcrowded Houston prison [17], showed that cell blocks with the worst combination of crowding and poor ventilation had the highest rates of respiratory disease. Exposure to second hand smoke caused by transfer of air between cells is another concern in prisons, where the prevalence of smokers typically is considerably higher than in the general population (e.g. Refs. [22,24]. These studies also showed that introduction of smoking bans resulted in large reduction in the inmates' exposure to second hand smoke and nicotine.

Based on measurements of indoor air contaminants and evaluation of health symptoms [21], found that sources of indoor pollutants, use and storage of chemicals, and inmate behaviour (in particular smoking) affected the prevalence of symptoms among inmates. High temperatures may not only lead to thermal discomfort, but stimulate misconduct or even aggressive behaviour [3,14]. Harsh physical conditions in prisons have also been shown to affect staff well-being, quality of life and sick leave [5]. Altogether, the findings from earlier studies indicate that the indoor environment and ventilation conditions should have a prominent role in the design of prisons to facilitate the best living and working conditions for inmates and staff.

The present study was conducted in parallel to an on-going extension project for a prison in Denmark. The aim of the study was to investigate indoor environment exposures and comfort conditions of the existing cells. The results and solutions proposed in the study should serve as guidance for the extension project team. The study comprised a field investigation, during which air temperature, relative humidity and carbon dioxide concentration measurements were taken and a questionnaire was used to record the inmates' assessment of their indoor environment.

2. Methodology

2.1. The prison

The prison is located in an urban area of Copenhagen, Denmark. It functions as a remand centre where people are incarcerated while they wait for a case trial. The study was conducted in the main building of the prison. In order to take into account as wide a diversity of indoor conditions as possible, all four wings of the building (West, North, East and South) were part of the study (Fig. 1). Each wing has four floors and the internal layout is the same for all floors: the cells are placed on each side of a central corridor, as seen on Fig. 2. The floors are connected by open stairs, rising from the middle of the corridor, except for the West wing where the first, second, and third floors are separated from each other.

Thirty-six (36) cells, housing 27 men and 9 women, as well as four corridors (one in each wing) were selected for data collection. An attempt was made to include cells of all orientations and at all floors, but the organisation of the prison made a balanced distribution of the cells impossible, some floors being reserved for isolation, newly incarcerated or special groups of inmates. The cells of the study were therefore selected by each wing manager, who chose inmates who had shown a calm behaviour so far, to limit any possible ill-willed acts toward the measuring instruments.

2.2. Measurements and instrumentation

The recordings of air temperature, relative humidity (RH) and CO_2 concentration were conducted during two weeks divided into two sessions of one week, from the 19th to the 26th of July 2013 (*week 1*) and from the 26th of July to 2nd of August 2013 (*week 2*), respectively, i.e. during the summer season in Denmark. It is worth noting that, at the time of the study, the weather in Copenhagen was exceptionally warm with outdoor temperatures up to 30.7 °C.

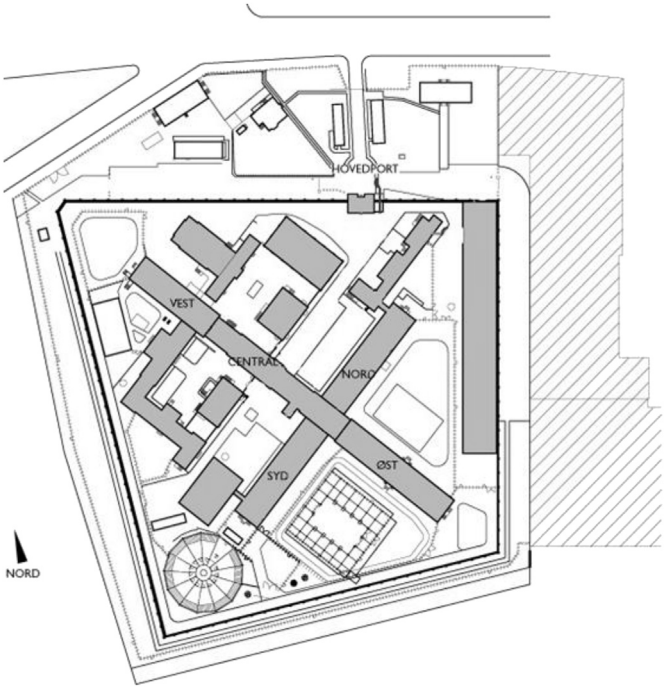

Fig. 1. Plan of the prison (Vest = West; Nord = North; Øst = East; Syd = South).

Fig. 2. Indoor disposition of the wings.