SUMMARY

S. Sainio et al: Ventilation in Existing Buildings, Part One. Comparative Studies of Various Ventilation Systems in Old Renovated Public Buildings. The author presents some of the most important challanges in renovation ventilation design, such as dramatic changes in the indoor and outdoor climate, compared to that in the original building, and the need to create adequate indoor air with low investment and running costs. Also presented here are the field measurements in two public buildings located in Helsinki city area with three ventilation systems of different types. The conclutions are as follows: In these two buildings only a balanced mechanical inlet/exhaust air ventilation system seems to fulfill the needs for satisfactory and healthy indoor environment. The main reasons for this are the problems with the dust and noise in the ground floor rooms (window ventilation). Also the radon gas concentrations were high in one of the buildings, due to the underpressure in the ground floor rooms (natural and mechanical exhaust air ventilation).

RESUME

S. Sainio et les autres: ventilation dans les bâtiments anciens. Première partie: Etudes comparatives de divers systèmes de ventilation dans des bâtiments publics rénovés. L'auteur présents les défis les plus importants du projet de ventilation de la rénovation tels les changements notables dans l'air ambiant extérieur et intérieur en comparaison avec le bâtiment d'origine, ainsi que le besoin de créer un air ambiant intérieur suffisamment bon à de frais de fourniture et d'utilisation les plus avantageux. On a présenté ici le mesurage de terrain de deux bâtiments publics situés dans le centre d'Helsinki avec trois types différents de systèmes de ventilation. Les conclusions sont les suivantes: dans ces deux bâtimentsl, seul le système de ventilation par alimentation/estraction mécanique équilibrée semble répondre aux exigences de satisfaction et d'hygiène de l'air ambiant. Les plus grandes raisons à cela sont la poussière et les problèmes du bruit dans les pièces du rez-de-chaussée (aération par les fenêtres). La teneur en radon était élevée dans le deuxième bâtiment à cause de la basse pression des pièces du rez-de-chaussée (ventilation par extraction naturelle et mécanique).

KURZFASSUNG

S. Sainio et al: Ventilation in alten Gebäuden. Erster Teil. Vergleich zwischen verschiedenen Ventilationssystemen in alten renovierten öffentlichen Gebäuden. Der Verfasser legt wichtigste Forderungen der Ventilationsplanung bei der Renovierung wie erhebliche Veränderungen in der Aussen- und Innenluft in Vergleich zum ursprünglichen Gebäude sowie den Bedarf, eine genügend gute Innenluft durch vorteilhafte Anschaffungs- und Betriebskosten zu schaffen, dar. Hierbei werden auch Vermessungen von zwei im Zentrum Helsinkis befindlichen öffenlichen Gebäuden durch drei Ventilationssysteme veschiedenen Types vorgestellt. Es werden folgende Schulsfolgerungen gezogen: Bei diesen zwei Gebäuden scheint nur das ausbalancierte maschinelle Einblase/Auszu erfüllen. Die wichtigsten Gründe dafür sind die Staub- und Lärmprobleme in den Zimmern des Erdgeschosses (Fensterlüftung). Der Radongehalt war im anderen Gebäude hoch. Dies hing mit dem Unterdruck in den Zimmern det Erdgeschosse zusammen (natürliche und maschinelle Ausströmungsventilation).

VENTILATION IN EXISTING BUILDINGS: PART ONE. COMPARATIVE STUDIES OF VARIOUS VENTILATION SYSTEMS IN OLD RENOVATED BUILDINGS

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Introduction

One of the most significant tasks in renovation ventilation design is to choose the optimum ventilation system, i.e. to get adequate indoor air with low investment and usage costs. Another great challenge for the engineer, of course, is the suitability of ventilation system to the architectural environment.

Individual challanges in ventilation design are for example dramatic changes in outdoor/indoor environment compared to the original building, such as:

- increased traffic with it's noise and dust
- alternating user habits and ventilation demands of different rooms, e.g. from office room to meeting room or v.v.
- removal of old stoves, which have acted as an effective part of original ventilation system
- better air tightness of the building envelope due to new windows or better window seals
- the original masonry ducts are partly in a neglected condition e.g. blocked or have serious leakages.

To get more information from practical cases, the National Board of Building has evaluated two renovated public buildings located in the Helsinki city area. Altogether three different ventilation systems were studied: a) natural ventilation and mechanical exhaust from toilets, b) mechanical exhaust from the whole building and c) balanced mechanical exhaust/supply.

Field measurements and analysis were done by the Technical Centre of Finland.

Objects

Building I

Building I is situated in the street Hallituskatu 3 and acts now as an office building for hte Ministry of Agriculture and Forestry. It's volume is about 6 300 cubic meters and it was built in 1840's by City Surgeon Pihlflykt. The building was renovated in 1972. Originaly it was equipped with natural ventilation combined vith fireplaces in every room. In rebuilding, the fireplaces were removed and a mechanical supply/exhaust ventilation was installed. The ventilation system caused already in the 1970's compalints by employees of draught and noise and the system was then closed so that only mechanical exhaust ventilation from toilets was on.

In this survey 18 per cent of those answering suffered continuously and 48 per cent temporarily from draught by ventilation system a), (1). Also the poor quality of indoor air was felt continuously in 16 per cent and temporarily in 45 per cent of cases.

Building II

Building II is from 1897, renovated in 1981, situated in Kasarminkatu 24, and it's volume is about 10 300 cubic meters. It acts today as the Museum of Architecture. It consist of two exhibition halls, library and office rooms for personnel. Original ventilation system and it's renovation system was designed so that all three types of system a), b) and c) could be tested.

Field measurements

Building I

The evaluation of ventilation system a) showed a poor air change rate of about 0,3 ac/h, which consisted of infiltration, mechanical exhaust from toilets and natural airing via windows, each corresponding to about 0,1 ac/h. The tightness of building is obviously rather poor. Average window leakage was 0,9 $dm^3/s,m$ by 50 Pa pressure difference, (2).

In ground floor rooms natural airing was practically impossible due to traffic dust and noise. Also high radon concentrations were measured in these rooms (See Table 1), (3).

Table 1. Results of evaluations in Building I

Measurement	Ventilation system a)	c)
Average air change rate, ac/h	0,26	0,55
Radon gas concentration Bg/m^3		
Average	100	60
max/min	320/30	150/50
number of measured rooms	10	5
Thermal climate	draught	ok
Energy consumption kWh/m^3, a	60	75

As a result of this evalution the National Board of Building decided to take the mechanical ventilation in to use again. Of course readjustment of air flows was necessary.

It was found too that the main obvious reason for earlier complaints of noise and draught were many changes in the use of various rooms after the ventilation system had been designed. Also some mistakes in directioning inlet supply air grilles were found.

The air flows were reduced from original designed value (about 1 ac/h in office rooms) to correspond with present design guidelines for rooms occupied by non-smokers (about 0,7 ac/h).

In interviews the users quite satisfied with ventilation system c), specially in the ground floor rooms. Only some smokers found the ventilation inadequate.

The total energy consumption by ventilation system c) increased by about 25 per cent, i.e. about DKK 60 per staff person per year. The radon concentrations were satisfactorily small, too.

Building II

In renovation of building II air tightness was improved. Even high windows with large areas provided low infiltration rates (see Table 2), (4). This showed clearly where the leakage points in the building were, e.g. the roof. It became a broblem specially in systems a) and b), where temporarily high overperssure in upper the part of the building caused moisture damage in the roof constructions.

The thermal climate was acceptable in all the ventilation alternatives a, b and c.

The air change rate was acceptable in systems b) and c). In systems b) and a) radon concentrations exceeded the limit values (5), obviously due to the underpressure in ground floor. Thus, only system c) can provide sufficient ventilation without local air quality and pressure problems.

Table 2. Results of evaluations in Building II.

Measurement	Ventilation system a)	b)	c)
Average air change rate, ac/h	0,2-0,3	0,7	0,7
Radon gas concentration Bg/m^3			
Average	480	450	250
max/min	840/260	610/350	320/50
number of measured rooms	6	5	6
Thermal climate	ok	ok	ok
Average tightness of the building, N_{50}			
windows, dm^3/s, m	0,13		
envelope, ac/h	2,0		

Conclusions

The evaluation of these buildings showed some remarkable points which must be taken into account when designing and using ventilation systems in renovated buildings:

- noise and draught problems must and can be avoided already in the design of ventilation systems
- when changing the user habit of rooms, the user should also take care of the readjustment of ventilation system
- in city areas forcing of natural ventilation by airing via windows is practically impossible due to traffic dust and noise
- in renovations in the Helsinki City area only a balanced mechanical ventilation seems to fulfill the needs for satisfactory and healthy indoor environment.

References

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