JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

STUDY AND ANALYSIS OF SICK BUILDING SYNDROME: A CASE STUDY REPORT ON RESIDENTIAL BUILDING

[1]Mrs Jaya Patil, [2]Pragati Ambegave, [3]Dnyaneshwar Bakle, [4]Akshay Barge, [5]Bhagyashri Birajdar

[1]Assistance Professor in Civil Engineering, [2]Student of civil engineering, [3]Student of Civil Engineering, [4]Student of Civil Engineering, [3]Student of Civil Engineering
Department of Civil Engineering.
Sinhgad Academy of Engineering, Pune, India.

Abstract : Housing is one of the elementary requirements of a human being and essential for health. Over 90% of people's time is spent indoors. Housing is progressively becoming a major public health problem. For many years, housing conditions have been identified as one of the essential settings that affect the health of human beings. During the 1970 s energy crisis, engineers and building managers were compelled to maintain and design the indoor environment more effectively by sealing the buildings. This resulted in a lower ventilation rate to save electricity.
SBS is also defined by mucosal, skin and general symptoms directly connected to houses and offices. SBS is characterized by a group of symptoms that have no recognized explanation. These symptoms are separated into mucous membrane symptoms affecting the eyes, nose, throat, and dry skin, as well as what is frequently referred to as general symptoms, such as headache and fatigue.

Keywords **- Sick Building Syndrome, Symptoms, Mucosal, Houses, Indoor Environment, Health Problems..**

I. INTRODUCTION

The sick building syndrome (SBS) is used to describe a situation in which the occupants of a building experience acute health- or comfort-related effects that seem to be linked directly to the time spent in the building. No specific illness or cause can be identified. The complainants may be localized in a particular room or zone or may be widespread throughout the building.

The sick building syndrome (SBS) is generally characterized by the following criteria: people in the same building complaining of mucous membrane irritation (such as eye, nose, or throat irritation), headache, dizziness, and difficulty in concentrating; the symptoms are relieved soon after leaving the building and the cause of the symptoms is usually not really known.

Apart from these allergic and infectious disorders, doctors are confronted every day with a number of complaints affecting mucous membranes of eyes, nose and throat, headache and lethargy. These symptoms appear to be benign and related to the building in which the individuals work or live and constitute the sick building syndrome.

Air pollution is one of the most serious global environmental issues, especially for human respiratory health. Air pollution can be classified into two groups depending on the environment: indoor air pollution and outdoor air pollution. It is a misconception that one is safe from dangerous contaminants at home. Indoor air pollution is significantly more serious than outdoor air pollution.

II. LITERATURE SURVEY

INDOOR AIR QUALITY (IAQ): -

As per a study of Llozor et al. (2001) prevalence of harmful natural and artificial substances combined with poorly ventilated interiors lead to various health problems among those who spend long periods indoors.

Table 2 illustrates factors affecting SBS in which indoor air quality related aspects were identified as main factors.

Table 2: Indoor Air as a Main Factor

Research	Factors affecting on SBS
Skov *et al.* (1990)	Sex, Job category, photocopying, handling of carbonless papers and **indoor climate factors**.
Bachmann and Myers (1995)	Personal factors, work organisation, gender roles and **indoor climate**
Redish *et al.* (1997)	**Air contaminants, ventilation,** work organisation, host factors
Runeson *et al.* (2004)	Personal factors, physical factors in **indoor environment**
Wong *et al.*(2007)	**Indoor air chemicals**, and high stress during work
Fisk *et al.* (2009)	**Indoor environmental conditions**, psychosocial conditions
Crook and Burton (2010)	Personal factors, female gender, lower Status, Building factors, office Dust, cigarette smoke, paper dust and other factors, **high indoor temperature, air conditioning**, outdoor air ventilation.

As per above studies, indoor climate is a major and common factor that affects SBS.
IAQ refers not only to comfort, which is affected by temperature, humidity and odours, but also to harmful biological contaminants and chemicals in the conditioned space. Illinois Department of Public Health (IDHP) consistently ranked indoor air pollution among top five environmental risks affecting public health. According to Bholah and Subratty (2002), IAQ leads to increased health related symptoms. Though being a tropical country Sri Lanka is expected to have good indoor ventilation, limited data suggest that indoor air is more polluted than outdoor (Nandasena et al., 2010).

Indoor climate is not a characteristically unique factor that causes several diseases. Skov et al. (1995) stated that indoor climate consists of several other factors, too.
Internationally, organizations observe certain IAQ standards to prevent prevalence of SBS.
Summary of such standards published by IDPH, ASHRAE and OSHA are shown in Table3.

Table 3: IAQ Standards (Source: Arnold, 2010)

PARAMETER	IDPH	ASHRAE	OSHA
Humidity	20% - 60 %	30% - 60 %	N/A
Temperature	68 - 75 (winter)	68 - 75 (winter)	N/A
	73 – 79 (summer)	73 - 79 (summer)	
Carbon Dioxide	1,000 ppm	1,000 ppm	5,000 ppm
	(<800 ppm preferred)		
Carbon Monoxide	9 ppm	9 ppm	50 ppm
Hydrogen Sulfide	0.01 ppm	N/A	20 ppm
Ozone	0.08 ppm	N/A	0.1 ppm
Particulates	0.15 mg/m^3 (PM 10) (150 µg/m^3) 24-hr 0.065 mg/m^3 (PM 2.5) (65 µg/m^3) 24-hr	50 µg/m^3, annual average (PM 10)	15 mg/m^3 (total)
			5 mg/m^3 (resp.)
Formaldehyde	0.1 ppm (office)	0.1 ppm (office)	0.75 ppm
	0.03 ppm (home)	0.04 ppm (home)	
Nitrogen Dioxide	0.05 ppm	N/A	5 ppm
Pressure relationship with Zones	N/A	Restroom mechanically exhaust with no recirculation	N/A
Outdoor air floor rate	N/A	10 L/s (20 cfm) per person	N/A

IMPACTS OF SBS IN OFFICE ENVIRONMENT: -
Office, physical and behavioural environments must match with workers' needs as they make an impact on workers' productivity (Wong et al., 2009). In an office environment workers have to work in the same working area for many hours continually in the same premises. Studies found that quality of an office building has a direct relationship with productivity. Unalterable evidence on above was contained in a survey submitted to UK Parliament by Burge (2004). It revealed statistics related to days of sickness absence per year attributed to sick building syndrome and hours per month dealing with or complaining about indoor environment. Thus, many studies reveal that productivity depends on working conditions of the office building and a main factor affecting such conditions is indoor air quality.

III. RESEARCH METHODOLOGY

3.1 Indoor Air Pollution by Household Parameters: -

Fan

Ceiling fans themselves do not produce pollutants. However, they can potentially contribute to indoor air quality issues indirectly. One primary concern is dust accumulation on fan blades. Over time, dust, dirt, and other particles can gather on the blades of ceiling fans, especially if not cleaned regularly.

Washing Machine

While we are cleaning our clothes, we are polluting our air. A typical U.S. household does about 300 loads of laundry every year and because our cleaning habits are bad for the environment, scientists want us to cut back.

Not only does washing our clothes this much use an excessive amount of energy, it also spews out tons of carbon dioxide. This is bad for the environment, and it wears down our clothes, which adds clothing to our landfills.

AC

Chlorofluorocarbons are the pollutants released from air conditioners and refrigerators. These pollutants damage the ozone layer present in the atmosphere creating ozone holes. The ozone layer absorbs harmful UV rays emitted by the Sun.

Oven

People use a variety of heat sources to cook food, including gas, wood, and electricity. Each of these heat sources can create indoor air pollution during cooking. Natural gas stoves can release carbon monoxide, formaldehyde and other harmful pollutants into the air, which can be toxic to people and pets.

Gas

Natural gas stoves can release carbon monoxide, formaldehyde and other harmful pollutants into the air, which can be toxic to people and pets. Using a wood stove or fireplace to cook can result in high levels of indoor air pollution from wood smoke.

Geyser

The possible attributable cause for these events could be exposure to high amounts of various toxic gases, mainly carbon monoxide (CO) released due to incomplete combustion of LPG in gas geysers in small ill ventilated bathrooms in homes.

Television

Manufacturers use a greenhouse gas called nitrogen trifluoride to make the televisions, and as the sets have become more popular, annual production of the gas has risen to about 4,000 tones.

Electric Points

These primary pollutants sometimes react with other chemicals in the air to produce secondary pollutants. Five of the most common primary air pollutants are carbon monoxide, sulphur dioxide, nitrogen oxides, volatile organic compounds, and particulate matter.

Refrigerator

Chlorofluorocarbons are the pollutants released from air conditioners and refrigerators. These pollutants damage the ozone layer present in the atmosphere creating ozone holes. The ozone layer absorbs harmful UV rays emitted by the Sun.

3.2 Questionnaire Survey Report of Two Buildings: -

Building No 1 Specification: -
Wing: - C
No Of Flats: - 16 (4 Per Floor)
Direction: - East-West

Table: - Symptoms of SBS In Building No 1

Symptoms	Cases		
	Age Group		
	<15	15-45	45<

Symptoms		Cases											
		Age Group											
		<15				15-45				45<			
		Reported		Not Reported		Reported		Not Reported		Reported		Not Reported	
		M	F	M	F	M	F	M	F	M	F	M	F
Eyes	Itching	5	2	1	1	12	3	12	3	5	6	0	0
	Dry eyes	4	3	2	0	5	5	8	3	5	6	0	0
	Itching eyes	2	3	5	1	8	6	3	3	4	6	1	0
	Watering eyes	3	3	3	2	4	2	7	8	3	2	2	3
	Eyes strain	0	0	5	2	3	2	10	6	1	1	4	4
Nose	Blocked or stuffy nose	6	3	4	3	2	4	1	2	2	2	3	3
	Running nose	5	0	1	2	5	2	1	1	3	5	6	3
	Other itching/irritation	0	2	4	0	4	5	0	4	1	2	4	3
Throat and Chest	Sore throat/cough	4	1	2	4	2	3	0	1	6	9	3	1
	Dry throat	6	5	1	3	3	1	0	2	5	5	4	1
	Chest tightness	2	3	3	2	0	2	3	0	3	2	2	2
	Breathing difficulty	4	4	4	1	6	9	3	4	4	2	3	1
	Flu-like symptoms	0	2	5	10	3	8	1	3		02	7	4
Skin	Itching face without rash	2	7	3	9	3	1	1	2	1	0	0	2
	Rash or irritated skin	3	2	1	1	1	5	4	5	6	4	2	5
	Other dry skin symptoms	2	3	4	1	1	2	2	3	5	6	3	1
General	Feeling heavy-headed	4	0	1	3	4	4	4	5	0	1	2	8
	Lethargy or tiredness	2	2	4	1	3	5	4	3	1	2	4	1
	Forgetfulness and/ or lack of concentration	2	1	4	2	5	1	8	9	2	1	3	5
	Other symptoms	2	0	4	3	2	1	10	9	1	1	3	3

Building No 2 Specification: -
Wing: - A2 A
No of Flats: - 16 (4 Per Floor)
Direction: - North-South

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		Reported		Not Reported		Reported		Not Reported		Reported		Not Reported	
		M	F	M	F	M	F	M	F	M	F	M	F
Eyes	Itching	3	1	1	1	9	7	1	2	2	2	0	0
	Dry eyes	3	1	1	1	6	6	4	3	1	1	1	0
	Itching eyes	3	0	1	2	4	4	6	5	1	0	0	1
	Watering eyes	0	0	4	2	4	4	6	5	0	1	1	0
	Eyes strain	1	0	3	2	2	1	8	8	1	0	0	1
Nose	Blocked or stuffy nose	3	1	1	1	5	5	5	4	2	2	0	0
	Running nose	4	2	0	0	7	4	3	5	1	0	1	1
	Other itching/irritation	0	0	4	2	3	3	3	6	0	1	2	1
Throat and Chest	Sore throat/cough	1	0	3	2	6	5	4	4	2	1	0	1
	Dry throat	4	1	0	1	8	4	2	5	1	0	1	2
	Chest tightness	2	0	2	2	5	2	5	7	1	1	1	1
	Breathing difficulty	4	2	0	0	5	5	5	4	2	2	0	0
	Flu-like symptoms	0	0	4	2	0	1	10	8	0	1	1	0
Skin	Itching face without rash	2	0	2	2	8	5	2	4	1	0	0	1
	Rash or irritated skin	2	0	2	2	6	6	4	3	2	2	0	0
	Other dry skin symptoms	3	1	1	1	4	2	6	7	0	0	1	1
General	Feeling heavy-headed	2	0	2	2	8	9	2	0	1	1	1	1
	Lethargy or tiredness	3	0	1	2	6	6	4	3	2	1	0	1
	Forgetfulness and/ or lack of concentration	2	1	2	1	8	3	2	6	1	2	1	0
	Other symptoms	1	0	3	2	1	2	9	7	1	1	1	1

Table: - Symptoms of SBS in Building No 2

3.3 Remedial Measures to prevent the sick building syndrome: -

Schedule HVAC Maintenance: -
Since the main cause of SBS is poor indoor air quality, a smart way to prevent it is by scheduling routine HVAC maintenance. Something as simple as changing air filters can greatly impact air quality.

Locate and Clean Up Wet Areas: -
If you suspect that Mold is the culprit behind the poor air quality in your building, try to find any sources of leaks and repair them. If you've noticed a water-stained ceiling tile or hear a dripping pipe, that may be where the Mold is growing. It's important to get professional help to remove the Mold because it can often be difficult to find and even harder to eliminate.

Use Cleaning Products with Low Fumes and No Fragrances: -
Many cleaning agents emit volatile organic compounds (VOCs) that may be negatively affecting the short-term health and long-term health of your building's occupants. Finding safer products with a low VOC count could be a simple trick to curing SBS.

Update Your Cleaning Schedule: -
If you're not regularly vacuuming or disinfecting, dust will accumulate and affect your building's indoor air quality. Stay on top of keeping all surface areas dust-free and clean.

Indoor Plants or Air Purifier Plants: -
Below are some of the best indoor plants for air purification process. These indoor plants which can clean the air, remove toxins and improve air quality in home.

IV. CONCLUSION

The survey confirmed the presence of sick building syndrome and its risk factors in the tropics. A biopsychosocial approach to the problem involving symptomatic treatment, environmental control, good ergonomic design, and stress management is recommended. There is proper HAVC system is needed for the prevention of sick building syndrome in the building.

V. ACKNOWLWDGMENT

We would like to thank **Mrs. J.P. Patil, Assistant Professor** for their complete guidance and support during the site visit and during the Academics as well as Curriculum. It was very helpful for us to have immense knowledge about Project Report and the various measures taken for it. It was helpful because the topic was somewhat different and something new.

VI. REFERENCES

[1] Arnold, D.T. (2010). Illinois department of public health guidelines for indoor air quality. Retrievedfrom:http://www.idph.state.il.us/envhealth/factsheets/indoorairqualityguide_fs.html.
[2] Bachmann, M.O., and Myers, J.E. (1995). Influences on sick building syndrome symptoms in three buildings. Social Science Medicine, 40(2), 245-251.
[3] Bholah, R., and Subratty A.H. (2002). Indoor biological contaminants and symptoms of sick building syndrome in office buildings in Mauritius. International Journal of Environmental Health Research, 12, 93–98.
[4] Burge, P. S. (2004). Sick building syndrome. Occup Environ Med, 61, 185-190.
[5] Crook, B., and Burton N.C. (2010). Indoor moulds, sick building syndrome and building related illness. Fungal Biological Reviews, 1-8.
[6] Fisk, W.J., Mirer, A.G., and Mendell, M.J. (2009). Quantitative relationship of sick building syndrome symptoms with ventilation rates. Indoor Air, 19, 159–165.
[7] Hedge, A., and Erickson, W.A. (1996). Predicting sick building syndrome at the individual and aggregate levels. Environment International, 22(1), 3-19.
[8] Llozor, B.D., Treloar, G.J., Olomolaiye, P.O., and Okaroh, M.I. (2001). FM puzzle: Sick building and Sydney's open-plan offices. Facilities, 19(13/14), 484-493.
[9] Morris, A., and Dennison, P. (1995). Sick building syndrome survey findings of libraries in Great Britain. Library Management, 16(3), 34–42.
[10] Nandasena, Y.K.S., Wickremasinghe A.R., and Sathiakumar N. (2010). Air pollution and health in Sri Lanka: A review of epidemiologic studies. BMC Public Health, 10, 300.
[11] Redlich, C.A., Sparer, J., and Cullen, M.R. (1997). Sick-building syndrome. Occupational Medicine, 349, 1013–16.
[12] Redlich, C.A., Sparer, J., and Cullen, M.R. (1997). Sick-building syndrome. The Lancet, 349, 1013-1016.
[13] Indoor Air Facts No. 4 (revised) Sick building syndrome. Available from: http://www.epa.gov/iaq/pubs/sbs.html.
[14] Purushottam K. The sick building syndrome. *Indian J Occup Health.* 2001;44:36–40. [Google Scholar]
[15] Martin-Gil, et al. *Hospital Management International.* Sterling Publications Limited; Outcome of research into a sick hospital. [Google Scholar]
[16] Breiman RF, Fraser DW. 13th ed. New Jersey: Prentice Hall International Inc; 1992. Legionelloisis, Maxy-Rosenau – Last: Public Health and Preventive Medicine; pp. 181– 2. [Google Scholar]
[17] Redlich CA, Sparer J, Cullen MR. Sick building syndrome. *Lancet.* 1997;349:1013–6. [PubMed] [Google Scholar]
[18] [PMC free article] [PubMed] [Google Scholar]
[19] *Sick building syndrome: Causes, effects and control.* London: Hazards Centre; [Google Scholar]
[20] IAQ publications. Sick building syndrome fact sheet indoor air facts no. 4 (Revised) Available from: http://www.epa.gov/iaq/pubs/sub.html-29k-