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CONTENTS

Prevalence of sick buildings in Uttarkashi District of Uttarakhand

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ABSTRACT: The purpose of the study was to find out the sick buildings which are cause of hazards among residents of the district Uttarakashi of Uttarakhand. Poorly designed, maintained, constructed and inefficient HVAC (Heating, Ventilation & Air Conditioning) system makes a building sick. Checklist and self-made questionnaire were developed to find out sick buildings. Purposive sampling technique was used to select 120 houses of the district and further divided into LIG, MIG and HIG on the basis of income of the householder. Frequency and per centage were used for the analysis of data. The study results suggested that most of the houses in study area were located near the site prone to landslides, steep slope, river catchment area and national highway. Maximum houses reported cracks, crumbs, dampness and problems of termites hence were recognized as ill building. Further building standards and housing by-laws are completely ignored by residents as well as by the people involved in construction, making housing risky and vulnerable to earthquake, flood, and landslide. Hence there is an urgent need to take up more researches in this direction as we are not aware about poor or ill housing.

Key words: Building by-laws, HVAC system, ill housing

A home perceived as safe and intimate unit provides major psychosocial benefits to us. It represents a protected refuge from the outside world, enables the development of a sense of identity and attachment – as an individual or as a part of a family, and provides a space to be oneself. Any intrusion of external factors or stressors strongly limits this feeling of safety, intimacy, and control, thereby reducing the mental and social function of the home (Kearns *et al.,* 2000). Sick building syndrome (SBS) is a poorly understood phenomenon where people have a range of symptoms related to a certain building and there is no specific identifiable cause. Sick building syndrome (SBS) occurs when the occupants of a building experience acute health effects that seem to be linked to time spent in a building. The complaints may be localized in a particular room or zone, or may be widespread throughout the building. Frequently, problems result when a building is maintained in a manner that is inconsistent with its original design or prescribed operating procedures, or when occupant activities create a problem. According to the American Standards for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), a building is deemed "sick" when 20% or more of the building occupants, voluntarily complain of discomfort symptoms for periods exceeding two weeks, and affected occupants observe rapid relief away from the building. According to the EPA (Environment Protection Agency, USA) problem trace to building being operated or maintained in a manner that is inconsistent with its original design or operating procedures. Sometimes indoor air problems trace to poor building design or activities. The health conditions associated with buildings are commonly classified as sick building syndrome and building related illness (BRI). Sick Building Syndrome symptoms include headache dizziness, nausea aches and pains, fatigue poor concentration, shortness of breath or chest tightness, eye and throat irritation, cold, irritated, blocked or running nose, skin irritation and cough etc. Sick building syndrome can be measured in terms of poor infrastructural facility, dilapidated housing conditions, geological concerns, poor maintenance, risky site selection and the extent to which housing standards and building by-laws are followed. Old building with mould and moisture area is the feeding ground to most biological organisms. Building has a leaky roof or window that has not sealed, or if moisture accumulates around the drip pans of cooling or heating system, so it could have major problem: black mould. Even new building can be potential hazard. Materials like some paints, carpets, adhesives, wallboard and other construction materials emit chemicals through a process called out-gassing. The chemicals escape into the air circulation of building. Hopton and Hunt (1996) conducted a longitudinal study by in Scotland assessed health before and after elimination of dampness/mould in Glasgow. The Electricity Board and the local authority joined forces to install a "Heat with Rent" scheme in dwellings on selected local authority estates, which provided controlled heating system in all rooms. The study used the same interview schedule as earlier Scottish studies (Hunt, Martin and Platt) with 3 interviews - before installation, and 6 months and a year later - in order to compare heat with rent with no heat with rent. The research actually showed a general deterioration in children's symptomatic health over the year; some symptoms increased, others declined. The researchers suggested that benefits from the improved heating system might have been offset by other influences, especially disadvantage.

The state of Uttarakhand is among the most seismically active part of India. According to Bureau of Indian standards (IS-1893-part-1:2002), Uttarakhand state comes under V Zone (very severe intensity zone), which covers 12 % of total area of India. Other major problems of state are landslide, flood, flash floods, soil erosion, heavy rainfall and migration. Hill towns in the Indian Himalayan region are experiencing high urbanization due to high population growth and increase in tourist activity, as a result hill towns have developed much more than their carrying capacities. Due to high urbanization hill towns are facing problems like, overcrowding, congestion, chaos, traffic problems, acute shortage of housing and infrastructure, encroachments, environmental degradation in the form of air, water and noise pollution, disturbance to surface and ground water sources, loss of vegetation, frequent and proneness to heavy damages during natural hazards, absence or poor quality of public spaces and loss of heritage, which results in poor living conditions and deterioration of the environment quality (and Ashwini and Pushplata, 2013)

Significance of the study

Several studies have been conducted on Sick Building Syndrome (SBS) in western countries. The leading researches were carried out by Professor Hedge, the only expert on above area. But in India there is a wide gap in research related to Building Related Illness (BRI) and Sick Building Syndrome (SBS), particularly in the mountain region of India, which is affected by geological aspects and natural calamities; need such researches to be initiated by governments and non-government organizations (NGOs) immediately. The reason is that houses of such mountain region occupy several illness and syndromes in the buildings which has direct impact on residents. Hence, there is an urgent need to take up such researches and this is one step in this direction.

There is transition from traditional housing to modern R.C.C. In this perspective, study becomes more important for us to find out problems people are facing about housing and housing conditions. All geological attributes will be studied which are also responsible for making houses sick. Hence present study, its methodology, finding, implication will open the space for more studies, fill up research finding gaps, and put pressure on government and non-government bodies to work on faulty construction and zero involvement of builder or architect.

Only one district of Uttarakhand is selected for the present study is the limitation of the study.

The objectives of the present study were to find out sick buildings in Uttarkashi District of Uttarakhand and to assess the knowledge of construction worker by developing knowledge assessment tool.

MATERIALS AND METHODS

Sample

Purposive sampling design was used to select the study area because Uttarkashi district of Uttarakhand state, study area for the present study, has religious significance in Indian Culture. It came to focus at world globe because of June 2013 flash flood natural calamity among most affected district in Uttarakhand in which many houses, bridges, animals, and people washed away with flood. Earthquakes, floods and landslides are major problems of study area which subsequently affect the stability of houses and causes death of many people due to collapse of houses. Total sample size was comprised of 120 families from Bhatwari block. These families were chosen from three provinces of block named Joshiyara, Gyansu and Barahaat deliberately as per convenience. Total families were drawn from each town and then 5 per cent of total families present in each study areas were selected randomly through chit from total sample till reached to designed size sample i.e., 120. Again, to see the effect of income on maintenance, construction and conditions of houses, the whole sample was divided into three different income group; Low Income, Middle Income and High Income Group. 43 houses belonged to Low Income Group (LIG) and Middle Income Group (MIG) each and rest 34 belonged to High Income Group (HIG).

Materials used/tools of the study

A self-made questionnaire and checklist has been developed, and in order to assess face and content validity of the instrument, it was sent to 03 different professors from civil engineering department of college of technology, G.B. Pant University of Agriculture and Technology for their feedback. For the people involved in house construction activities, knowledge assessment tool was developed to assess their knowledge regarding housing terminology and building standards.

Procedure

Data for the present study is collected in two different phases; one following another from three different sub study area. Prior to data collection, a visit was made to each of the selected study areas in order to establish rapport with respondents.

Phase I

In first phase descriptive data was collected from fourty samples from study area i.e., Gyansu, personally by using interview schedule and checklist. Another forty samples collected from second sub study area Joshiyara, which comes under a village province. Next forty samples collected from third study area Barahaat, which comes under main municipality.

Phase II

After collecting data from three different study areas knowledge assessment tool were used to collect data from local construction workers, civil engineers, and architects, and interior designers, private contractors on their knowledge about housing standard, building by-laws, geological condition and climatic condition.

RESULTS AND DISCUSSION

Description of Houses

Location of the houses

Location of the houses was studied under four categories i.e., at steep slope, at middle of the slope, at the down end of the slope and at low lying areas. It was observed that overall maximum houses i.e., nearly 36 per cent houses were located in low lying areas and only about 4 per cent houses were in steep slope. More steep slopes are prone to landslides as well as failure of retaining walls. Retaining walls are comparatively stiff structures designed to hold soil in place so that it can be held at various depths on both sides. The purpose of retaining walls is to hold soil to a slope that it would not naturally follow.

On comparing among all income groups, in LIG equal per centage of houses i.e., 32.55 were located in the down end of the slope as well as in low lying areas and only 2 per cent houses were located in steep slope. While, in MIG nearly i.e., 37 per cent houses were located in low lying areas and least 6.97 per cent houses were located in steep slope. In HIG, majority of the houses i.e., about 41 per cent houses were located in low lying areas and only 23.52 per cent houses were in middle slope. From the above data it was observed that more houses were located down end of the slope which may suffer slope failures such as slide, debris flow and mud flow when material move downside and cause accidents to houses as well as people. Table 1 gives the general information about the houses.

Type of Houses

The data on type of houses revealed that on the whole maximum about 84 per cent houses were permanent and rest only10.83 per cent houses were semi-permanent. Houses with wall and roof made of permanent materials called permanent house. Wall can be of Galvanized Iron (G.I.), Metal, Asbestos sheets, Burnt bricks, Stone or Concrete. Roof can be made up of Tiles, Slate, G. I., Metal, Asbestos sheets, Brick, Stone or Concrete. And in semi-permanent house either wall or roof is made of permanent material (and the other having been made of temporary material).

Among all income groups, maximum i.e., about 77 per cent houses were permanent and only about 23 per cent houses were semi-permanent in LIG whereas in MIG most of the houses i.e., 79.06 per cent were permanent and least i.e., 20.94 per cent houses were semi-permanent. In HIG, all houses were permanent type of houses. Thus, LIG and MIG followed the same trend while HIG was distinct with all permanent type of houses.

Type of Buildings

Type of building was classified into three categories i.e., single storey, double storey, multi-storeyed building. The result showed that maximum about 59 per cent houses were single storied while only 10 per cent houses were multi-storeyed as shown in Table 1. On the comparison among all different income groups, in LIG maximum i.e., 72.09 per cent houses were single storied and very few i.e., 6.97 per cent houses were multi-storeyed while in MIG maximum about 49 per cent houses reported with single storied and only 4.16 per cent houses were multi-storeyed. Same trend was also observed in HIG with maximum multi-storeyed houses due to high income economic status.

Orientation of Houses

The building orientation is generally referred to the solar orientation while planning of house with respect to sun path. All rooms in a house should be designed to receive as much sunlight as possible to kill the bacteria that tend to multiply in the presence of moisture.

The results of present study revealed that overall maximum i.e., about 57 per cent reported east facing houses and rest only 5 per cent reported south facing.

Data in Table 1 showed that in LIG majority of the houses i.e., about 63 per cent were east facing and very few 4.65

Table 1: General Information about the Houses

S.N.	Information	LIG n= 43	MIG n=43	HIG n=34	Total N=120
1	Location of the houses				
	a. At steep slope	2(4.65)	3(6.97)	-	5(4.16)
	b. At middle of slope	13(30.23)	9(20.93)	8(23.52)	30(25.00)
	c. At the down end of the slope	14(32.55)	15(34.88)	12(35.29)	41(34.16)
	d. At low lying area	14(32.55)	16(37.20)	14(41.17)	44(36.66)
2	Type of houses				
	a. Permanent	33(76.74)	34(79.06)	34 (100)	101(84.16)
	b. Semi-permanent	10(23.25)	9(20.93)	-	19(15.83)
3	Type of building				
	a. Single storied	31(72.09)	21(48.83)	19(55.88)	71(59.16)
	b. Double storied	9(20.93)	17(39.53)	11(25.58)	37(30.83)
	c. Multiple storied	3(6.97)	5(4.16)	4(11.76)	12(10)
4	Orientation of houses				
	a. East facing	27(62.79)	26(60.46)	16(47.05)	69(57.5)
	b. West facing	14(32.55)	8(18.60)	14(41.17)	36(30.0)
	c. North facing	2(4.65)	4(9.30)	3(8.82)	9(7.5)
	d. South facing	-	5(11.62)	1(2.94)	6(5.00)
5	Accessibility to roads				
	a. Yes	34(79.06)	31(72.09)	20(58.82)	85(70.83)
	b. No	9(20.93)	12(27.90)	14(41.17)	35(29.16)
6	The houses is near to				
	a. National Highway	20(46.51)	23(53.48)	13(38.23)	56(46.66)
	b. River catchment area	6(13.95)	3(6.97)	4(11.76)	13(10.83)
	c. site prone to landslide	4 (9.30))	10(23.25)	6(17.64)	20(16.66)
	d. On the course of stream	1(2.32)	1 (2.32)	2(0.58)	4(3.33)
	e. Not of the above	12(27.90)	6(13.95)	8(23.52)	26(21.66)
7	Construction system of houses				
	a. Concrete	19 (44.18)	26(60.46)	21(61.76)	66(55.00)
	b. Masonry	8(18.60)	7(16.27)	9(26.47)	24(20.00)
	c. Wood	3(6.97)	-	-	3(2.5)
	d. Mixed of all	13(30.23)	10(23.25)	4(11.76)	27(22.5)
	e. Any other	-	-	-	-
8	Direction of open area of houses				
	a. No open area	12 (27.90)	6(13.95)	8 (23.52)	26(21.66)
	b. Front Side	17(39.53)	17(39.53)	11(32.35)	45(37.5)
	c. Back side	2 (4.65)	4(9.30)	-	6(5.00)
	d. Right side	2(4.65)	1(2.32)	-	3(2.5)
	e. Left side	-	-	-	-
	f. Any two sides	7(16.27)	9(20.93)	7(20.58)	23(19.16)
	g. All sides	-	6 (13.95)	7 (20.58)	13(10.83)
9	Distance between house from a stream/ a river				
	a. Within 10 meters	16(37.20)	11 (25.58)	9(26.47)	63(52.5)
	b. 10- 20 meters	15(34.88)	13(30.23)	13(38.23)	47(39.16)
	c. Beyond 20 meters	12(27.90)	9(20.93)	12(35.29)	10(8.33)
10	Houses with retaining walls				
	a. Yes	9(20.93)	13(30.23)	9(26.47)	31(25.83)
	b. No	36(83.72)	30(69.76)	25(73.52)	89(74.16)

per cent reported north facing while in MIG maximum i.e., 60.46 per cent houses were observed with east facing and only very few about 9 per cent houses reported west facing. In HIG most of the houses i.e., 48 per cent were east facing and only 2.94 per cent were having south facing. During the summer, solar radiation is most intense in the east and west. West is a crucial orientation, because high levels of solar radiation are absorbed in the evening, when internal gains are also at their highest.

Accessibility to Road

The study conducted showed that in totality a maximum of about 71 per cent of houses were connected to roads but only 29.16 per cent houses lacked connectivity to roads.

Among all income groups, majority of the houses i.e., 79 per cent were connected to roads and only 20.93 per cent were not connected in LIG, while in MIG maximum i.e., 72.09 per cent houses were connected to roads but 27.90

per cent houses were not. Mostly i.e., about 59 per cent houses of HIG were connected to roads and about 41 per cent were not.

Hazardous Area

The data revealed that on the whole maximum i.e., about 47 per cent houses were near to national highway prone to particulate matter indoor air pollution, 16.66 per cent were in or near to the site prone to landslide, 10.83 per cent were near to river catchment area, about 4 per cent were on the course of stream and 21.66 per cent houses were safe from above hazardous site as given in Table 1. As per the general building requirement no house shall be located closer than 10m to a steep slope and also to a river bank. But on the other hand houses in study area were breaching this requirement as shown in the picture 4a and 4b.

It was noted that in LIG maximum houses i.e., about 47 per cent houses were near to national highway and minimum 2.32 per cent houses were on or near to course of stream while 28 per cent houses were at safe place. Same trend was also seen in MIG and HIG. 13.72 per cent houses of MIG and 23.61 per cent houses of HIG reported at safe place. From the data presented on the Table 1, it was clear that almost maximum houses of all income groups were near to hazardous place. This may be because of people were less concerned about geographical attributes and lack of knowledge about site selection and very less involvement of civil engineers and architects in study area.

Construction System of the houses

The results on construction system revealed that overall maximum i.e., about 55 per cent houses had concrete system of the houses, whereas 22.5 per cent houses were having mixed construction system of the houses, 20 per cent houses had masonry construction system of houses and minimum i.e., about 2.5 per cent houses reported wooden construction system.

4a: Houses near catchment area

4b: Houses near landslide prone area

Among all income groups, in LIG maximum i.e., 44.18 per cent houses had concrete construction system while only 6.97 per cent houses observed with wood construction system. In MIG majority of the houses i.e., 60.46 per cent had concrete construction system while none of the houses reported wooden construction system. In HIG majority of the houses i.e., 61.46 per cent while very few about 12 per cent houses had mixed construction system.

Availability of Open Space

Availability of open space is necessary for the recreational activities and gardening and for mobility. Analysis of the data showed that maximum i.e., 78.34 per cent houses had open space. Most of the houses i.e. , 37.5 per cent houses were having open space in front side while only about 3 per cent houses had open space in right side.

On comparison among all income groups, in LIG about 40 per cent houses had open space in front side only whereas very few i.e., 4.65 per cent houses reported open space in back side. 27.90 per cent houses observed with no open space. In MIG maximum i.e., about 40 per cent houses were having open space in front side and very few i.e., 2.32 per cent houses had open space in right side and 13.95 per cent houses reported no open space. In HIG majority of the houses i.e., 32.35 per cent houses had open space in front side and minimum i.e., 22.58 per cent houses reported open space in two sides of houses and in all sides of houses each separately.

4c. Cracks on a wall

4d. Damped roof of a house

4f. Staircase beyond normal height of riser

4e. Staircase without handrailing

Distance of houses from a stream or a river

It was found that overall majority of the houses about 35 per cent houses were located between 10- 15 meters away from a river or a stream whereas only 27.50 per cent houses were located beyond 20 meters away from a river or a stream.

It was noted that in LIG maximum i.e., 37.20 per cent houses were within 10 meters away from a river or a stream while only 27.90 per cent houses were located beyond 20 meters from a river or stream. In MIG largest number of houses i.e., 30.23 per cent were between 10-15 meters away from a river a stream and only 20.93 per cent houses were located beyond 20 meters from a river or a stream whereas in HIG maximum about 39 per cent houses were within 10 meters away from a river or a stream, and only 26.47 per cent houses were located beyond 20 meters from a river or a stream. Hence it was observed among all income groups majority of the houses were located near to a river or a stream and hence earthquake, floods become the cause of their damage.

Retaining walls

A retaining wall is a structure that holds back soil or rock from a building, structure or area. Retaining walls prevent down slope movement or erosion and provide support for vertical or near-vertical grade changes. Results in Table 1 depicts that overall maximum i.e., 25.83 per cent houses were having retaining wall whereas 74.16 per cent houses were not having any retaining wall.

It was reported that in LIG only 20.93 per cent houses were observed with retaining walls while rest 83.72 per cent houses had no retaining walls whereas only about 30 per cent houses were having retaining walls and rest about 70 per cent not reported any retaining wall in MIG. In HIG 26.47 per cent houses were having retaining wall and about 74 per cent were not. It was observed that, in study area heavy rains bring about soil erosion down and make houses vulnerable to slide.

Description of Sick Building

As far as the walls of the total sample is concerned, overall most of the houses i.e. 70 per cent houses were having cracks on walls showed in image 4c, 40.83 per cent houses with problems of leakage, mould and odour. In totality maximum 58.33 per cent houses were observed with problem of water accumulation during rainy season due to sloppy surfaces. In case of windows, results showed that overall about 33 per cent houses had small horizontal windows with 48.83 per cent facing in east direction. Approximately 40 % per cent houses of Low Income Group reported height of window sill inappropriate. It was observed that almost all houses were lacking aesthetics, architectural and elements of arts features missing among all houses including design and construction of the windows. 49 per cent house reported leaky roofs presented in image 4d.

About 11 per cent houses reported missing doors. Among all income groups 23.52 per cent houses had doors with inappropriate height, 34.88 per cent houses had with inappropriate width and only 16.27 per cent houses of Middle Income Group reported inappropriate height and 81.39 inappropriate width. High Income Group was observed with adequate height and width and less problem of missing doors, fungus and mould as compare to other different income groups.

Data on ventilator revealed that 44.16 per cent houses had ventilator with inadequate width, about 22 per cent houses reported ventilator which were either very high or low from floors. Among all income groups 18.60 per cent houses reported ventilators either very high or very low from floor. Largest number i.e., 37.20 per cent houses in Low Income Group had broken or missing windows.20.93 per cent houses had either very high or low from floors, 46.51 per cent houses had inadequate width and only 9.30 per cent problems of fungus and mould on ventilators in Middle Income Group. Whereas in High Income Group 26.47 per cent houses had ventilators either very high or very low from floor and only 5.88 per cent observed problems of fungus and mould on ventilators.

Overall 13 per cent houses had staircases without hand railing, 53.33 per cent houses reported staircases where riser and tread were too high and too low. On comparison among all income groups, 16.27 per cent houses were without hand railings showed in image 4e, 46.51 per cent houses complained staircases where handrails were not easily reachable and usable and more steps were noisy in Low Income Group. Maximum houses of Middle Income Group i.e. 23.25 per cent were without hand railings. Among all income groups about 30 per cent staircases of High Income Group observed wrong dimensions of tread and riser (image 4f). All houses of High Income group reported hand railing in their staircases and 76.47 per cent houses reported slippery treads.

Description of knowledge assessment of people involved in construction

People involved in construction were only two housing experts, one was civil engineer and another was architect, working in study area since last decade. They

Table 2: Description of Sick Buildings

S.N.	Statements	LIG (n=43)		MIG (n=43)		HIG (n=34)		Total (N=120)	
		Y	N	Y	N	Y	N	Y	N
	A. Floor								
1.	Dampness on the floor	22 (51.16)	21 (48.83)	15 (34.88)	28 (65.11)	8 (23.52)	26 (76.47)	45 (37.5)	75 (62.5)
2.	Crack or crumbs	26 (60.46)	17 (39.53)	24 (55.81)	19 (44.18)	14 (41.17)	20 (58.82)	64 (53.33)	56 (46.6)
3.	Floor have even surface	23 (53.48)	20 (46.51)	26 (60.46)	17 (39.53)	21 (61.76)	13 (38.23)	70 (58.33)	50 (41.6)
	B.Walls								
1.	Walls seepage, mould, and odor	21 (61.76)	22 (51.16)	20 (46.51	23 (53.48)	8 (23.52)	26 (76.47)	49 (40.83)	71 (59.19)
2.	Walls with cracks	32 (74.41)	11 (25.58)	28 (65.11)	15 (34.88)	24 (70.58)	10 (29.41)	84 (70)	36 (30)
3.	Walls half plastered	17 (39.53)	26 (60.46)	8 (18.6)	35 (81.39)	2 (5.88)	32 (94.11)	27 (22.5)	93 (77.5)
4.	Walls with no paint or half painted	19 (44.18)	24 (55.81)	18 (41.86)	25 (58.13)	7 (20.58)	27 (79.41)	44 (36.66)	76 (63.33)
5.	Walls that are cracked, rotted, or in need of major repair	16 (37.20)	27 (62.79)	11 (25.58)	32 (74.41)	4 (11.76)	30 (88.23)	31 (25.83)	89 (74.16)
C.	**Roof**								
1.	Roof peeling off	17 (39.53)	26 (60.46)	14 (32.55)	29 (67.44)	6 (17.64)	28 (82.35	37 (30.83)	83 (69.16)
2.	Provision of water drains and vents	22 (51.16)	21 (48.83)	26 (60.46)	17 (39.53)	26 (76.47)	8 (23.52	74 (61.66)	46 (38.33)
3.	Leakage in roof	23 (53.48)	20 (46.51)	22 (51.16)	21 (48.83)	14 (41.17)	20 (58.82	59 (49.16)	61 (50.83)
D.	**Windows**								
1.	**Type**								
	a. Large horizontal	5(11.62)		21(48.83)		14(41.17)		40(33.33)	
	b. Large vertical	6(13.95)		4(9.30)		7(20.58)		17(14.16)	
	c. Small horizontal	17(39.53)		9(20.93)		8(23.52)		34(28.33)	
	d. Small vertical	15(34.88)		9(20.93)		5(14.70		29(24.16)	
2.	**Direction**								
	a. South facing	9(20.93)		5(11.62)		5(11.62)		19(15.83)	
	b. North facing	11(25.58)		1(2.32)		9(26.47)		21(17.50)	
	c. East facing	18(41.86)		22(51.16)		9(26.47)		49(40.83)	
	d. West facing	-		7(16.27)		-		7(5.83)	
	e. More than two direction	5(11.62)		8(18.60)		11(32.35)		24(20.00)	
3.	Opening								
	a. Inside	37(86.04)		41(95.34)		33(97.05)		111(92.5	
	b. Outside	6(13.95)		2(4.65)		1(2.94)		9(7.5)	
4.	Height of sill adequate	26 (60.46)	17 (39.53)	29 (67.44)	14 (11.66)	23 (67.64)	11 (32.35)	78 (65)	42 (35)
	E.Door								
1.	Heights appropriate	33 (76.74)	10 (23.25)	36 (83.72)	7 (16.27)	25 (73.52)	9 (26.47)	94 (78.33)	26 (21.66)
2.	Broken or missing	8 (18.6)	35 (81.39)	4 (9.3)	39 (90.69)	1 (2.94)	33 (97.05)	13 (10.83)	107 (89.16)
3.	Width appropriate	28 (65.11)	15 (34.88)	34 (79.06)	9 (26.47)	21 (61.76)	13 (38.23)	83 (69.16)	37 (30.83)
	F. Ventilator								
1.	Height appropriate	35 (81.39)	8 (18.6)	34 (79.06)	9 (20.93)	25 (73.52)	9 (26.47)	94 (78.33)	26 (21.66)
2.	Broken or missing	16 (37.2)	27 (62.79)	10 (23.25)	33 (76.74)	6 (17.64	28 (82.35)	32 (26.66)	88 (73.33)

3.	Width appropriate	24 (55.81)	19 (44.18)	23 (53.48)	20 (46.51)	20 (58.82)	14 (41.17)	67 (55.83)	53 (44.16)
	G.Staircase								
1.	Height and width of staircase is appropriate	19 (44.18)	24 (55.81)	21 (48.83)	22 (51.16)	24 (70.58)	10 (29.41)	64 (53.33)	56 (46.66)
2.	Hand railings	35 (81.39)	8 (18.6)	36 (83.72)	7 (16.27)	34 (100)	-	105 (87.5)	15 (12.5)
3.	Height of the steps & depth of tread inconsistent	22 (51.16)	21 (48.83)	19 (44.18)	24 (55.81)	10 (29.41	24 (70.58)	53 (44.16)	67 (55.83)
4.	Handrails easy to reach and useable	23 (53.48)	20 (46.51)	32 (74.41)	11 (25.58)	24 (70.58)	10 (29.41)	79 (65.83)	41 (34.16)

were basically involved in planning part of the house or drawing housing plan for people but execution of plan was done by the contractors who were migrated from the state of Bihar. When these contractors interviewed it was found that presently approximately 10 contractors are involved in construction of houses in study area. Further they reported that neither they have acquired any training and technical education regarding to the construction of house nor they have attended any workshop or training program conducted by state government. Most of them were unaware about basic housing terminologies mentioned in figure 1. Also they lacked knowledge about housing standards incorporated in figure 2. Hence people or residents and contractors were free to take their own decision regarding to the construction of houses clearly ignoring housing standard and building by-laws.

GENERAL BUILDING REQUIREMENTS FOR HILLY REGION

The provisions contained in this part shall apply excepting for the specific provisions given here under.

- **Siting**

1. No house shall preferably be located closer than 1m to another house.
2. No house shall be located closer than 10m to a steep slope.
3. No house shall be built on a landfill or on the edge of a slope known to have been leveled.
4. Buildings in hills shall be clustered together to minimize the exposure to cold winds. Open spaces provided shall allow for maximum South sun.
5. Buildings shall be located on the south slope of a hill or mountain for better exposure to solar radiation. At the same time, exposure to cold winds may be minimized by locating the building on the leeward side.

- **Passive Systems for Climatic Control**

1. Appropriate solar passive methods, such as orientation, double-glazing, trombe walls and solar collectors, shall be adopted to achieve climatic comfort with little use of conventional energy.

2. Care shall be taken in siting and design of buildings to provide passive controls to modify the effect of cold/strong winds.

3. Flat land is normally not available in hilly regions. The houses are required to be constructed on partially sloping land made available by cutting and filling. It shall be necessary to protect the house by building retaining walls/breast walls to avoid landslides occurring at time of earthquakes or heavy rains

(Source : National Building Code of India 2005)

BY-LAWS FOR HILL HOUSING

- **Height of buildings**

1. In hilly region maximum height 12 meter and plain region maximum height 21 meter is permissible.
2. Height of building should be measured from plinth level

- **Internal routs**

Development of internal routs in residential housing should be as below:

Minimum width of route	Maximum length of route
4.5 meter	200 meter
6 meter	201-400 meter
7.5 meter	401-600 meter
9.0 meter	601-1000 meter
12 meter	More than 1000 meter

- Setback

Plot area (square meter)	Minimum required setback (meters)			
	Front	Back	Right	Left
75	1.5	-	-	-
76-150	1.5	1.2	-	-
151-250	2.0	1.5	-	-
251-350	3.0	2.0	1.2	-
351-450	3.5	3.0	1.2	1.2
451-550	4.5	3.5	1.5	2.0
551-750	5.5	4.0	2.0	2.5
751-1000	6.6	5.0	3.0	3.5
More than 1000	7.5	6.0	4.5	4.5

*above setbacks allowed for 12 meter high buildings

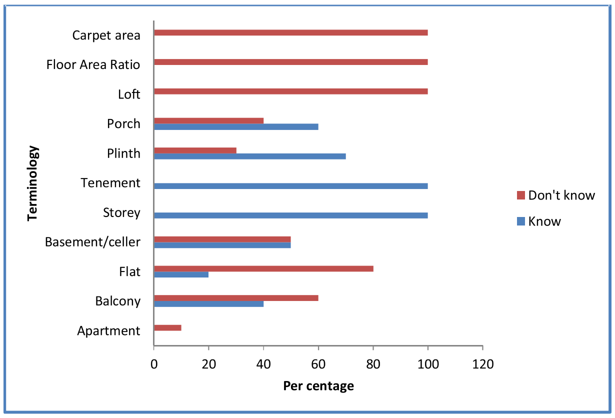

Fig. 1: Knowledge of contractors regarding housing terminology

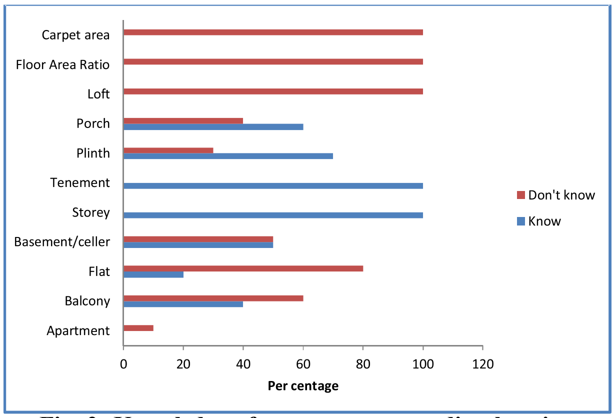

Fig. 2: Knowledge of contractors regarding housing terminology

- **Earthquake safety related provisions**
  For the safety from the earthquake, development of earthquake resistant building is mandatory. Before the development of building certificate from architecture, structural/ civil engineer should mention that structure design is according to the national building code of India part -IV
- **Distance from water sources/bodies**

(1) 10-10 meter distance from river bank / ground water bodies should be left for plantation and any kind of development activities is not permissible.
(2) Distance from blank of canals should be 5-5 meters each side.
(3) No development/ constructional activities are permissible within the diameter of 30 meter from the surface of natural lakes.

- **Group housing**

1. Minimum plot area for hills = 1000 square meter
2. Minimum plot Width= 15.0 meter
3. Density – 100 residential unit/ hectare

Source: (Mussorrie Dehradun Development Authority Building By-laws 2012).http://mddaonline.com/others/ By_laws_2011_part_2.pd

CONCLUSION

Housing is valued all across the world by all countries due to its capacity, significance, and importance in promoting public good and to create a vibrant and productive society. Rapid migration from high altitudes to lower altitudes there is burden on these urbanized valleys for living space, so resulting in compromise with housing standards and building by-laws thus resulting in unhealthy or sick buildings. Inappropriate site selection was the major factor affecting overall quality of built environment. As far as building components of the houses in study area concerned, dampness, leakage, seepage, mould and odour were more prevalent problem and thus giving rise to unhealthy indoor built environment. Government should play an important role to create awareness among people and persons involved in construction about Housing Standards and building by-laws and make strict rules to ensure the follow up of all housing standards and building by-laws.

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