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EFFECTS OF WIND ON SCHOOL STRUCTURES IN KOGI WEST SENATORIAL DISTRICT, KOGI STATE, NIGERIA

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Abstract

The main purpose of this study is to find out the effects of wind on structures in Kogi West Senatorial District of Nigeria. Research design was based on ex-post facto research design, also population of the study were the urban, semi-urban, rural areas or cities, towns and Kogi villages in Kogi-West Senatorial District of Kogi State of Nigeria. The instrument used was a structured questionnaire. The target population for this study are the residents in cities, towns and villages in Kogi West Senatorial District. Random Sampling was used to draw samples from all the cities, towns and villages in the State. Two residents responded out of every town, village and cities. Also method used in analyzing data gathered through the Research question was the simple mean standard deviation and ANCOVA. Results from the study showed that shoddy design, location, and neighbouring structures lead to negative effects of wind on structures. Furthermore, it was adduced that unobstructed location or within 1,500 feet of open water leads to effect of wind on structures. It was therefore recommended that by proper protection and maintenance of homes and properties would minimize damage of buildings. Also, services of architects, engineers and builders would give room for structural perfections.

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Introduction

Effects of wind on school structure have been so disastrous in recent times especially in cities, towns and villages in Kogi West Senatorial District of Kogi State, Nigeria. Howbeit, it is not a seclusion to Kogi State or Nigeria but global. The effects have been so generalized for both high–rise buildings and just very low buildings. The issues of aero elastic flutter and aero dynamics are very strong stances for effects of wind on structures in the whole world. Albini, Tailor & Francis, (2008) observed that while the interest of attendees are focused mainly upon fire and wind in man made structures, many of its studies are relevant to and applied in modeling of wild land fire phenomenology.

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It was further noted by Albini et al.(2008) that, interest by the general public in matters of wild land fire and winds on high-rise buildings has grown with increased exposure of affluent society to the hazards posed by building flammable structures.

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Similarly, Rehm, R.G, Hamins, A., Baum H.R, Mcgrattan, K.B & Evans, D.D (2001), reviewed literature on the potential energy content of various wildland fuels and wind and compared these numbers with the potential energy content of structures. This was applicable to cities like Kabba, Lokoja, Ekinrin-Adde, Aiyetoro-Gbedde; among others. Schools like Egbeda-Kabba, Out-Kabba had battered structural defects during a windy rainfall-sometimes ago.

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Table 1. Types of wild fires / winds, rate of spread (ROS)

And intensities as reported by Albini.

Also shown are fuel / wind energy implied by these values.

TYPES OF WILDFIRE/ WINDS	SPREAD RATE (mi/h)	ROS (m/s)	INTENSITY (mw/m)
Ground fire/wind	0.00003	0.0000083	0.0001
Surface fire/wind			
Marginal conditions	0.01	0.003	1
Good conditions	10	2.77	10
Wind	20	5.54	1
Debris	1	0.277	10
Crown	3	0.833	10

Source: Albini

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In Table I, one could deduce that wind has a very high rate of spread when it comes to destructive capability and it must be curbed as soon, as it starts to spread.

From the analysis and synthesis curled from Table I, efforts must be geared up to curtail excesses of wind destruction to school structures in Kogi West Senatorial District, Nigeria.

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Table 2: Characteristic scaling for cases of wind:

Parameter	wind (low)	wind (medium)	wind (high)
Structure density [No/acre]	4	4	1
L. [M]	32	64	128
I. [MW/M]	5	5	5
U [M/s]	1	1	1
t [S]	36	36	36
Mg [Kg/M^2]	0.06	0.06	0.06
h. [Mj/kg]	20	20	20
e. [MJ/M^2]	1.2	1.2	1.2

Source: Rehm, R . G

L= length between structures [the spatial period {M}.

I= the wild intensity {MW/M}.

U= the rate of spread {ROS} of the wild front {M/S}.

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r = the passage time for the wild front{s}.

Mg = the mass of wild land fuel per unit area {Kg/M^2}.

h = windable energy per unit mean of wildland fuel {MJ/Kg}.

1 acre= 4047m^2

1 hectare = 10,000m^2)

It was postulated that their are three different types of effects of wind on structures; static, dynamic and aerodynamic. The response of load depends on type of structure. When the structure deforms, in response to wind load then becomes dynamic and aerodynamic effects should be analyzed. In addition to static effect. Howbeit, sound knowledge of fluid and structural mechanics helps in understanding of details of interaction between wind flow and Civil engineering structures.

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When taken into cognizance a high–rise buildings to wind gusts, both along–wind and across-wind responses must be considered. These arise from different; the former being primarily due to buffeting effects caused by turbulence; the latter being primarily

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due to alternate-side vortex shedding. The cross-wind response may be of particular importance because it is likely to exceed along-wind acceleration if the building is slender about both axes.

Furthermore, any building or structure which does not satisfy either of the above two criteria shall be examined for dynamic effects of wind:

(a) Buildings and closed structures with a height to minimum lateral dimension ratio than 5.0 and

(b) Buildings and closed structures whose natural frequency in the first mode is less than 1Hz.

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Wind induced oscillation.

Wind induced oscillation are of three forms of induced motion as follows:-

a) Galloping – Galloping is transverse oscillation of some structures due to the development of aerodynamic forces which are in phase with the motion. It is characterized by the progressively increasing amplitude of transverse vibration with increase of wind speed. Circular cross sections are more susceptible to this types of oscillation.

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b) Flutter- this is unstable oscillatory motion of a structure due to coupling between aerodynamic force and elastic deformation of the structure. Perhaps the most common form is oscillatory motion due to combined bending and torsim. Long span suspension bridge decks or any member of a structure with large values of d/t (where d in the depth of a structure or structural member parallel to wind stream and t is the least lateral dimension of a member) are prone to low speed flutter.

c) Ovaling: this walled structures with open ends at one or both ends such as oil storage tanks and natural draught cooling towers in which the ratio of the diameter of minimum lateral dimension to the wall thickness is of the order of 100 (hundred) or more, prone to ovaling oscillations.

These oscillations are characterized by periodic radial deformation of the hollow structure. All these were postulated by Manohar, S.N (1985).

Similarly, the dynamic component which essentially causes the oscillation of structure is generated due to two reasons:

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1. Gust and vortex shedding: the wind velocities at any location vary considerably with time. In addition to a steady wind; their are effects of gusts which last for few seconds, and yields a more realistic assessment of wind load. In practice the peak gust are likely to be observed over an average time of 3.5 to 15 seconds depending on location and size of structure. The intensity of gusts is also related to the duration of gusts that affects structures. Larger structure will be affected more by gust of smaller pressure compared to smaller structure.

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2. The gust-effect factor accounts for additional dynamic amplification of loading in the along-wind direction due to wind turbulence and structure interaction. This does not include allowances for across – wind loading effects, vortex shedding, instability, deformation due to galloping or flutter, or dynamic torsional effects. Buildings susceptible to these effects should be designed using wind tuned results. This factor accounts for the increase in the mean wind loads due to the following factors.

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Finally, vortex shedding. This applies to when wind acts on a bluff body forces and moments in three mutually perpendicular directions are generated out of which three are translational and three; rotational.

Consider a prismatic building subjected to a smooth wind flow. The originally parallel upwind streamlines are displaced on either side of the building due to boundary layer separation.

However, one could see naturally that wind affects different homes in different ways, depending on their design, location and neighbouring structures. Among other things the wind can do collapse windows and doors, rip off roof sheathing (decking) and destroy gable and walls. Overhanging eaves and rakes; extending awnings, open porches and other features that tend to trap air beneath them are particularly susceptible to damage. Wind-borne debris can break windows and damage roof coverings and walls. With or without the help of wind-blown objects, the wind can break through a garage door, window or door on the windward side of the house and more inside, causing uplift forces for more than double. In fact, these powerful forces can literally lift the roof right off the house.

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Albeit, if house is in an unobstructed location or within 1,500 feet of open water, are more susceptible to damages caused by high winds. Landscaping can shield home and divert winds around the building.

Purpose of the study

Mainly this study intends to examine the effect of winds on structures in Kogi West Senatorial District of Kogi State.

1. Determine whether effects of wind on structures is due to their design.

2. Determine whether effects of wind on structures is due to their location.

3. Determine whether effects of wind on structures is due to their neighbouring structures.

4. Determine whether effects of wind on structures is due to their unobstructed location or within 1,500 feet of open water

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Research questions

The following research questions were raised for the study:

1 .To what extent does designing structures leads to effects of wind on structures?

2. To what extent does location of structures leads to effects of wind on structures?

3. To what extent does neighbouring structures leads to effects of wind on structures?

4. To what extent does unobstructed location or within 1,500 feet of open water leads to effects of wind on structures?

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Methodology

The research design adopted is survey – type, for this is very adequate for this research.

Population for this study are all settlements which can be captioned as urban, semi-urban, rural areas in Kogi West Senatorial District Kogi State, Nigeria.

Random sampling technique was used for the purpose of selecting unbiased sample. The sample space was 25 buildings from the urban,

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semi-urban, and rural areas or cities, towns, villages from Kogi West Senatorial District.

The main instrument for data collection was the structured questionnaire. The questionnaire has two sections: A and B.

Section A consists of general questions on personal data while section B consists of questions that are related to the research questions that elicited data and information on the research questions. Each item has four point likert scale of strongly involved (SI), Moderately involved (MT), Involved (I), Never involved (NI) or Strongly Agreed (SA), Agreed (A), Disagreed (D), Strongly Disagreed (SD)

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The questionnaire contains demographic and personal data respectively:

To measure the reliability index of the instrument, it was administered twice on the respondents different from the sample. 60 Science Education Structures, 40 Agric Structures, 40 Physical Education Structures and 40 Structures of Guidance and Counseling were tested. This is to connote with the face and content validity respectively. The method of test and retest which spanned a period of two weeks was used. The two tests were then correlated through the use of Pearson

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product moment correlating coefficient. The result of r= 0.78 was obtained.

Method of Data Collection

The researcher personally went to the selected urban, semi-urban, rural areas or cities, town and villages to administer the copies of the questionnaires with the aid of an assistant on the respondents. He collected immediately filled copies of the questionnaires from the respondents for processing. These are mixtures of functionally illiterate and literate people.

Method of Data Analysis

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The data collected were analyzed using Mean, Standard Deviation to answer the research questions.

Data Presentation

In analyzing Research question one (1): which states, to what extent does shoddy design location and neighboring structures leads to effects of winds on structures?

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Table (1):

S/N	EX	EX^2	Num.	Degree Of Freedom	Sig. level	Calc value	Critical table value
4	100	2500	4	3	0.05	22.9	3.182

Since Calculated Value (CV) = 22.9

Critical table value (Ctv) = 3.182

22.9 > 3.182

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Hence, Null Hypothesis (H_0) is rejected

Inference: Shoddy design, location and neighboring structures leads to effects of winds on structures.

Also, in analyzing Research question two (2): Which states, to what extent does unobstructed location or within 1,500 feet of open water leads to effects of winds on structures?

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Table (2):

S/N	EX	EX^2	Num.	Degree Of Freedom	Sig. level	Calc value	Critical table value
4	104	2708	4	3	0.05	23.9	3.182

Since Calculated (CV) =23.9

Critical table value (Ctv) = 3.182

23.9 > 3.182

Hence, Null Hypothesis (H_0) is rejected

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Inference: Unobstructed location or within 1,500 feet of open water leads to effects of winds on structures.

DISCUSSION OF RESULT

In analyzing the research question 1 (one), which states that to what extent does shoddy design, location and neighbouring structures leads to effects of winds on structures? From table 1 analysis, one could see that calculated value was put at 22.9, while critical table value was put at 3.182. Hence, the null hypothesis was rejected. An inference was culled from the analysis as thus: “shoddy design,

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location, and neighboring structures leads to effects of winds on structures". Winds therefore have effects on structures. One could say that, by properly protecting and maintaining your home and property, you can minimize potential damage to your neighbor's home as well as your own. If you are uncertain about whether your house needs changes, call a qualified professional architect, engineer, building contractor or your local building department.

A roofing professional can best determine when you should replace an aged roof. You also may need a professional to determine how well a door or window frame is anchored to the exterior walls.

Furthermore, in analyzing Research question 2 (two); which states that to what extend does unobstructed location or within 1,500 feet of open water leads to effects of winds on structures? Also, from table (2) analysis; one could infer from it that calculated value was put at 23.9; while critical table value was put at 3.182. Hence, the hypothesis was rejected. An inference was then drawn from the analysis as thus: '' unobstructed location or within 1,500 feet of open water leads to effects of winds on structures". Therefore, if your house is in an unobstructed location or within 1,500 feet of open water, you are more susceptible to damages caused by high winds. Landscaping can shield your home and divert winds around the building.

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Conclusion

Based on the discussion so far via shoddy design, location and neighbouring structures that it lead to effects of wind on structures. This can cause a lot of damages and destructions. Also, it was adduced that unobstructed location or within 1,500 feet of open water leads to effects of wind on structures. Hence it was concluded that landscaping can shield your home and divert winds around the building.

Recommendations

The followings were the recommendations made as a result of the conclusion proffered:

1. By properly protecting and maintaining your home and property, you can minimize potential damage to your neighbour's building.

2. It is recommended to employ the services of architects, engineers (Civil and structural etc), and builders.

3. A roofing professional services must always be employed.

4. Landscaping must be done properly.

5. Garbage cans, lawn furniture, tree limbs, landscaping pebbles, boulders must be cleared.

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