American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-5, Issue-1, pp-96-99
www.ajer.org
Research Paper Open Access

Effects of Fire Outbreak, Gas Flaring, And Global Warmings on Building and Structures

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ABSTACT: *The effect of fire outbreak, gas flaring and global warming on building and environment has been considered. Different residential, commercial and industrial buildings were considered at insitu fire gutted conditions and at perimeter distance intervals of 100m, 120m, 140m, 160m, and 180m away from the flare stack respectively. The Non-destructive tests were carried on the structural members and non structural members of these facilities to determine the integrity and strength. The observed gutted markets stanchions has a minimum steel stanchion yielding strength of 9.5N/mm^2 and a maximum yielding strength of 22.8N/mm^2 for 152 stanchion studied at a temperature range of over 200°c to 300°c of 2 to 3 hours fire intensity. The observed average room temperature for vary distance intervals were 33°c, 28°c, 26°c, 25°c , 24°c, away from the flare stack. The observed strength of other structural elements i.e. beams; columns and slabs were of minimum value 9.81N/mm^2 and maximum value of 23.05N/mm^2. The result therefore suggests that there is appreciable deterioration in the strength of both structural and non structural member due to fire outbreak, gas flaring and global warming in building.*

Keywords: *Elements, Fire, Gas, Member and Strength.*

I. Introduction

All construction materials are susceptible to change or deformation under certain conditions especially when there is an appreciable change in temperature. Temperature variation affects both the chemical and physical properties of these materials both at monolith nature and as individual material. The effect in some cases causes shrinking, melting, and charring. The associated moisture content variation and chemical decomposition affect the strength of these materials in its monolith nature as structural members and non structural members in buildings. Therefore since the strength of these member determines the strength of the buildings and by implication the safety and consequently the habitability of the facilities in an environment. Then, the investigation of the effects of fire outbreaks, gas flaring and global warning on the materials in any environment needs to be investigated to ensure safety and habitability.

Literature review: Olukotu and Akpopenamone (2010) in a thesis titled “Effects of fire outbreak on structural elements (beams, slabs, columns) and other non structural components”, describes the extent of failure that took place in Agbodo market, Benin city due to fire outbreak. The study was carried out to ascertain the extent of fire damage on 152 stanchions, 3 columns and 1 external beam. Expert visual inspection result revealed several defects like exposure of part of trusses to the atmosphere, collapse of columns, spilling and peeling of paints, buckling of steel, cracks on the block walls, columns and beams. Expert experimental test result shows that the reduction in the observed yielding strength of 152 stanchions, columns, slabs was in the range of (70 – 80%) as the minimum observed shootings @ X = 0°, X = +90° and X= -90° were 15N/mm^2, 16N/mm^2 and 12N/mm^2 and the maximum observed compressive strength were 39N/mm^2 and 25N/mm^2. The engineers and architects should recognize the environment as a system, and these artefacts as sub system. Therefore structural stability, functionality, temperature variation and resistance should be encompassed. The protection of the environment and sub environment e.g building markets should go hand in hand. Under intense heat, non structural elements collapse (glass shatters, plastic melts, timber burn). Global warming and environmental changes has equally been proofed to cause failures in building. Ifekwe (2008) in a thesis titled a “Crack Monitoring and Risk Analysis in Building” a case study of some laboratory facilities, it was observed none of the cracks in the building was traced to foundation settlement. Most of the cracks are caused by roots of plant, water ingression and material separation at fracture.

A formal risk management approach was adopted to help identify dominant risk to public health safety and security propagating due to contraction and expansion because of weather change, water will infiltrate the cracks between block and thereby aid the growth of plants whose roots will equally cause more cracks and subsequent deterioration of the building. The study applied both the visual inspection technique (VIT) and the dry timber wedge (DTW) technique in analyzing the 5 (fire) sections of the laboratory building facilities and found out that the cracks are in p4 width band of (2 -5) mm. the DTW crack monitoring method shows further that for six month monitoring the increase in crack width is negligible, since the timber wedge used did not fall off and tape did not slide for more than six months of monitoring. In some portions, the crack falls within p 0 to p1 crack width range of (0.1 – 0.3) mm, structurally refers to the hairline cracks and fine cracks. In the final analysis, the crack propagates horizontally along the weak mortar joint partition joints and wall joints. Otobo (2010) carried out a progressive monitoring of structural defects and cracks, a case study of the same facility by Ifekwe (2008), two years later and agreed totally with Ifekwe (2008) findings and concluded that cracks in the roof portion was caused by water ingress into the building due to the stagnant water in the roof gutter. Iroro (2008) in a thesis titled "Effect of Fire on Building Structural Elements (using INEC Zonal Office, Okada as a case study). The study noted that the temperature of the fire gust was in the range of 300°c to 600°c. The color of affected concrete members (structural & non structural) was found to be black, greenish and gray, Iroro confirmed the very weak obtained compressive strength of the concrete members by moulding six sample specimen and purposeful subjecting these specimen to oven temperature in the range of 180°c to 200°c for 2 hours thereby simulating a fire model. The maximum compressive strength of 9.8N/mm^2 was obtain which is very small in compression with 24N/mm^2 minimum compressive strength as specified in BS 8110 (1997, 1985), ISO (1975), SFDE (2002). The study concluded that the building suffered several damages and should be rebuilt from ground zero. Therefore it has rendered that particular environment inhabitable. Okeibuno (2011) studied "the effect of temperature on the strength of concrete". The purpose of the study was to investigate the effect of temperature on the strength of concrete, the study adopted 3 mix ratio of 1:2:4, 1:1 ½ :3 and 1:3:4, a total of 192 cubes of standard specimen of (150x150x150)mm comprising of 64 cubes for each mixture were made. These cubes were oven heated at regulated temperature of 80°c, 100°c, 120°c and 140°c and four sample were each tested at different maturity days of 7, 14, 21, and 28 days. Okeibuno tested result shows that there is a progressive increase in strength from (11.1 to 21.3) N/mm^2, (8.5 to 20.5) N/mm^2 and (13.4 to 23.5) N/mm^2 for different ratio. The result further shows serious distortion in the progressive increase sequence of a naturally curing concrete cube. In the entire sample tested, the minimum compressive strength of 24N/mm^2 was not obtained in 28 days even at the maximum considered temperature of 140°c. However okeibuno's work was inconclusive because severe fire conditions were not considered at sustained fire temperature of 200°c and above. Ekong (2008) carried out a research on "Effect of Gas flaring on the Environment and Civil Engineering structures, A case study of IBENO local government area, Akwa Ibom State" and Ezeagu and Eze (2009) worked on "Effect of Gas Flaring On structural Elements in Niger Delta (A case study of IBENOEXXON MOBIL QUA IBOE TERMINAL (Q.I.T)" They noted that global warming and gas flaring both poses a serious threat to the environment, life and property. Over the past decades,based on the rapid advancement in industrialization, which has lead to the depletion of the ozone layer, by the emission of greenhouse gases into the atmosphere. This causes a corresponding rise in the average temperature of the earth. The causes and effects of global warming have been taken into consideration with particular attention to how global warming affect the environment, health, eco-system and civil engineering structures; how it affect these buildings and deteriorates them causing a reduction in the strength of the reinforced concrete members. The structural integrity (strength) of the concrete members of the tested buildings was subjected to non-destructive testing by the use of a rebound hammer (Schmidt type). The results showed that gas flaring has no immediate effect on the strength of concrete but rather this effect is time dependent.

II. Methodology

Two important approaches were used in accessing the effect of fire out break and gas flaring cum global warming. In the first part, a schmit hammer was used to carry out rebound shooting on 152stanchions in the rolls of 8 numbers. This is because the Agbado market was constructed on multibay portal frames.

On the second part, residential buildings were located at perimeter distances of 100m,120m,140m,160m and 180m, and thermometers were installed at the walls of the building to obtain the room temperature variations because of gas flaring. But generally, the standard methods of using the rebound hammer for testing elements were employed as thus. The strength of the structural elements is measured using the concrete rebound hammer usually referred to as the Schmidt hammer. According to BS1881: part 202; ASTM C805, The hammer is a hand held instrument used for testing the quality of hardeness in the structure. This is done to obtain the gained increase strength on a structure. The guiding principle is that the rebound of an elastic mass impacting on the concrete surface is a function of the hardness of the surface. Therefore the harder the surface, the greater is the rebound distance.

The procedure adopted is:

1. The surface is abraded with carborundum stone to remove irregularities.
2. The hammer is pushed firmly against the concrete until the trigger button is automatically released.
3. The hand pressure is then reduced to allow the plunger to fully emerge from the instrument.
4. Extra hand pressure is then applied to push the plunger back into the instrument, compressing the internal spring to the point the trigger mechanism overrides and causes the impact force to be applied to the surface.
5. While applying the hand pressure, the push button is pressed to the plunger in place, retaining the reading on the graduated scale.

The corresponding strength to the reading on the scale is then noted strength of these two case and the are table 1. and table 2.

III. Results

Tables 1: Average strength of 152 Stanchion Non destructively tested at Agbado Market: @ Olukotu S. and Akpopenamone P. (2010).

S/no	1st line@5m	2nd line@5m	3rd line@5m	4th line@5m	5th line@5m	6th line@5m	7th line@5m	8th line@5m
1	10N/mm^2	14.9N/mm^2	18.4N/mm^2	16.8N/mm^2	19.4N/mm^2	22.8N/mm^2	18.9N/mm^2	19.9N/mm^2
2	10N/mm^2	15.9N/mm^2	18.3N/mm^2	17.3N/mm^2	21.4N/mm^2	22.8N/mm^2	18.9N/mm^2	19.9N/mm^2
3	10.5N/mm^2	15.4N/mm^2	18.4N/mm^2	15.2N/mm^2	20.7N/mm^2	22.8N/mm^2	19.6N/mm^2	20.5N/mm^2
4	20.4N/mm^2	15.4N/mm^2	18.3N/mm^2	16.9N/mm^2	20.7N/mm^2	18.9N/mm^2	19.1N/mm^2	18.6N/mm^2
5	19.2N/mm^2	15.9N/mm^2	10N/mm^2	18.4N/mm^2	21.6N/mm^2	17.3N/mm^2	20.9N/mm^2	18.7N/mm^2
6	18.5N/mm^2	11.8N/mm^2	10.6N/mm^2	18.9N/mm^2	18.8N/mm^2	17.1N/mm^2	19.9N/mm^2	17.3N/mm^2
7	17.3N/mm^2	11.8N/mm^2	15.6N/mm^2	17.9N/mm^2	18.7N/mm^2	16.9N/mm^2	18.7N/mm^2	20.4N/mm^2
8	18.9N/mm^2	11.8N/mm^2	15.4N/mm^2	17.3N/mm^2	17.4N/mm^2	17.7N/mm^2	20.9N/mm^2	18.9N/mm^2
9	12.8N/mm^2	15.6N/mm^2	17.8N/mm^2	18.3N/mm^2	17.6N/mm^2	18.4N/mm^2	18.7N/mm^2	15.3N/mm^2
10	15.9N/mm^2	16.2N/mm^2	17.9N/mm^2	13.4N/mm^2	15.2N/mm^2	17.7N/mm^2	19.9N/mm^2	20.4N/mm^2
11	18.9N/mm^2	19.3N/mm^2	17.9N/mm^2	13.9N/mm^2	16.6N/mm^2	18.4N/mm^2	20.9N/mm^2	18.1N/mm^2
12	18.6N/mm^2	18.5N/mm^2	18.3N/mm^2	12.4N/mm^2	15.7N/mm^2	21.4N/mm^2	18.7N/mm^2	18.8N/mm^2
13	17.8N/mm^2	12.6N/mm^2	17.1N/mm^2	14.3N/mm^2	17N/mm^2	19.4N/mm^2	18.9N/mm^2	14.3N/mm^2
14	16.9N/mm^2	12.2N/mm^2	18.3N/mm^2	16.7N/mm^2	20.6N/mm^2	18.1N/mm^2	18.9N/mm^2	17.2N/mm^2
15	18.6N/mm^2	15.6N/mm^2	17.7N/mm^2	18.1N/mm^2	21.4N/mm^2	18.1N/mm^2	18.4N/mm^2	17.9N/mm^2
16	19.5N/mm^2	14.2N/mm^2	16.6N/mm^2	19N/mm^2	21.4N/mm^2	18.4N/mm^2	18.9N/mm^2	19.9N/mm^2
17	18.5N/mm^2	15.6N/mm^2	16.8N/mm^2	17.1N/mm^2	22N/mm^2	18.9N/mm^2	18.1N/mm^2	19.2N/mm^2
18	14.7N/mm^2	17.9N/mm^2	13.1N/mm^2	9.5N/mm^2	21.4N/mm^2	18.9N/mm^2	17.1N/mm^2	20.6N/mm^2
19	15.9N/mm^2	19.9N/mm^2	13N/mm^2	18.8N/mm^2	22.2N/mm^2	18.9N/mm^2	17.1N/mm^2	18.7N/mm^2

Table 2: Summary of result of effects of gas flaring and globalwarming on residential building@ Imone(2007)

S/No	Perimeter@100m	Perimeter@120m	Perimeter@140m	Perimeter@160m	Perimeter@180m
Temp	33°c	28°c	26°c	25°c	24°c
Colunm	11.12 N/mm^2	10.56 N/mm^2	11.38 N/mm^2	12.66 N/mm^2	10.56 N/mm^2
slab	23.05 N/mm^2	9.81 N/mm^2	9.81 N/mm^2	13.93 N/mm^2	19.62 N/mm^2
beam	12.33 N/mm^2	12.4 N/mm^2	15.26 N/mm^2	14.84 N/mm^2	13.73 N/mm^2
wall	12.33 N/mm^2	9.8 N/mm^2	9.81 N/mm^2	9.81 N/mm^2	10.73 N/mm^2

IV. Discussion

The study has presented the effects of fire outbreaks, gas flaring and global warming in buildings. Table 1 shows the loss of yielding strength as a result of fire out break in a martket. The rate at which markets in Nigeria are burnt down is becoming alarming and these results tend to portray that there is a strength reduction. In the first two to three columns of table 1 the obtained result tends to be less than the other rolls of the columns and as the result moves down the rows, the strength increases. The value obtained confirms the oral investigation report that perhaps that the first three columns were the points where the fire started. The minimum yielding strength obtained was 10N/mm^2 and the maximum yielding strength was 22.2N/mm$^{2.}$ It was equally observed that the obtained frequently occurred strength was 18.9N/mm^2. Furthermore, the table 2 shows how structural elements stress varies with the distances of the building from the flare. The research is aware that though the buildings are not prototype buildings and are not constructed in the same standard and specifications. The observed deterioration as temperature values increase is obvious, hence the valves of the compressive strength decreases as the atmospheric temperature decrease.

Conclusion: The study has demonstrated physically that there is a reduction in structural and non structural elements especially those used by various governments to erect markets for the masses. Such reduction in strength is thus an index to suggest that the structure has failed in strength and functionality. The author has equally observed that there is reduction in strength of both structural and non structural members of building within the gas flaring perimeter. However, there is need to carry out a research which is time dependent of prototype building built of the same specification to evaluate the effects of gas flaring and global warming.

Recommendation: Fire study in buildings and facilities research has to commence in Nigeria, explosion study and Vibrational study also need to commence too. The selection of members to 2 to 3 hours of fire has not been adhering to in building and fire protection has been seriously negelected in major public buildings. This should be enforced by every end user and National Orientation Agency should enlighten the masses.

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