INVESTIGATING THE USE OF IMPLODING METHOD OF BUILDING DEMOLITION IN ONITSHA METROPOLIS, ANAMBRA STATE, NIGERIA

[1]EZEOKOLI F. O., [2]UGOCHUKWU S. C., [4]DULUORA J. O. & [4]IKPEAMA J. I.

[1,4]Department of Building, Nnamdi Azikiwe University, Awka
[2]Department of Quantity Surveying, Nnamdi Azikiwe University, Awka
[3]Department of Environmental Management, Nnamdi Azikiwe University, Awka
Corresponding E-mail: sc.ugochukwu@unizik.edu.ng

ABSTRACT

The existence of a building structure after its service life period is very dangerous to its occupants and surrounding buildings. Hence, the old structures need to be demolished for replacement by new structures. The aim of this study was to investigate the use of imploding method of building demolition with a view to establishing factors affecting its utilization. Data was collected via structured questionnaire administered to the managing Directors of 70 registered building construction firms in Onitsha and the 2 Directors of Anambra State Physical Planning Board though purposive sampling and analysed using mean score index. Findings revealed that the prevalent methods of building demolition are hand/manual method (Mean= 4.60), heavy machinery razing operation (Mean= 4.24) and mechanical demolition method (Mean= 3.54). But dismantling method (Mean= 2.68), pressure bursting method (1.36) and imploding method (Mean= 1.10) were rejected as building demolition method in the study area. It was also established that the level of awareness on imploding method is poor (Mean= 1.10) and is limited to the use of dynamite (75%). The respondents accepted that the factors that affect the use of imploding method of building demolition are lack of technical expertise (Mean= 4.40), low level of awareness (Mean= 4.13), unavailability of explosives in the open market (Mean= 4.09) and government stringent rules and regulations on explosive (Mean= 3.65). They further agreed that public enlightenment (Mean= 4.54), provision of professional training (Mean= 4.42), and establishment of building implosion department at every military base (Mean= 4.01) are necessary for the use of imploding demolition method to be improved. It was thus recommended that demolition experts in Onitsha should be properly trained on the use of the imploding method, proper licensing of users of implosive demolition devices by the defence Ministry, public awareness programme on the use of imploding methods and introduction of a course on “Demolition Methodology” in higher institutions offering Building discipline.

KEYWORDS: Building, Building Demolition, Onitsha, Anambra State, Imploding

INTRODUCTION

The existence of the structure after the useful or service life period is very dangerous to its occupants and surrounding buildings. Ogundele, Ayo, Odewumi, & Aigbe (2011) observe that many of the structures in Nigeria have already passed their design life and need to be reconstructed for safety and operational requirements. For this purpose, the old structures need to be demolished and replaced by new ones. Non-adherence to development control master plan can also cause buildings to be demolished by the concerned authorities. Izueke and Eme (2013) note that poor urban planning in the face of rapid urbanization is one of the major problems confronting many urban areas in Nigeria with special reference to Onitsha Metropolis. Izueke and Eme (2013) further state that the infrastructural degradation that has taken over Onitsha is a result of poor urban planning. The failure of land sub-division and servicing programmes to keep pace with rapid urban growth has led to the wide spread of illegal development hence, the growth of squatter settlement or slum areas in Okpoko, Feggae, Woliwo, Odoapku, etc.

Demolition is the tearing-down of buildings which involves taking a building apart while preserving the valuable elements for re-use (Rathi & Khandve, 2014). Demolition also means dismantling, razing, destroying or wrecking any building or structure or any part by pre-planned and controlled methods. Demolition methods can vary depending on the area where it will take place, time available, the building material, the purpose of the demolition and the way that debris is going to be disposed. Time saving methods of demolition is more expensive than the slower ones. If noise, dust, and vibrations are to be restricted, it will add to the cost of demolition. Small structures can be demolished by manual methods but machinery and advanced techniques are required for demolition of bigger structures. Advanced techniques are also required for faster demolition and demolition in confined areas.

Khairul (2012) outlines the building demolition methods to include: hand demolition method, heavy machinery razing operation, pressure bursting method, dismantling method, mechanical demolition and Imploding method. Use of any of these methods requires a proper understanding of the structure and the use of appropriate methods at minimising the risks of causing damage to persons, properties and the neighbourhood environment. Jalandar, Kanade, & Kulkarni (2014) describe implosion or imploding as an event where something collapses inward, because the external atmospheric pressure is greater than the internal pressure. In Imploding method of building demolition entails the use of explosives.

Anecdotal evidence suggests that the imploding method of building demolition is not prevalent. Emission of dust to air occurs during demolition and this emission can vary substantially from day to day, depending on level of activity, the specific operations being undertaken and the weather conditions. However, Gomes (2010) notes that, unlike imploding method, the use of manual and mechanical demolition method makes the duration of this air pollution to be longer. Besides, these conventional or non-explosive methods contribute to the concentration of airborne particles and Nitrogen dioxide. Nitrogen dioxide is due to the exhaust emissions from diesel powered vehicles and equipment used on site (non- road mobile machinery). Consequently, Tah (2006) advocates for a faster demolition method to curtail this pollution. Similarly, Patel, Jayeshkumar and Bhavsar (2015) advise that imploding method which has excellent demolition strength, shortens demolition period and reduce labour should be encouraged.

Olajumoke (2009) notes that several building demolition projects are executed across Nigerian cities. This is to regulate physical development and curtail sporadic development of illegal building structures (Kio-Lawson et al., 2016). Jalandar et al., (2014) suggests that when a building is surrounded by other buildings, it may be necessary to "implode" the building, that is, make it collapse down into its foundation. We can demolish a stone wall with a sledgehammer, and it's fairly easy pull down a three story building using excavators and wrecking balls. But when there is need to bring down a massive structure, say a 5-story the big implosion guns will be more appropriate. Explosive demolition is the preferred method for safely and efficiently demolition of larger structures. Yet, none of the several buildings demolished within Ontisha Metropolis is done using imploding method. It is against this backdrop that this study sets out to investigate the use of imploding method of building demolition in Onitsha Metropolis Nigeria.

Aim and Objectives of The Study

The aim of this study is to investigate the use of imploding method of building demolition in Onitsha metropolis of Anambra State. The following objectives are the premise for achieving this aim:

(i) To ascertain the prevalent reasons for building demolition in the study area
(ii) To determine the methods employed for building demolition in the study area
(iii) To determine factors affecting the use of imploding methods of building demolition in the study area

(iv) To proffer strategies for improving the use of imploding methods of building demolition in the study area

Literature Review:

Buildings Demolition and Processes.

Demolition can be defined as "dismantling, razing, destroying or wracking any building or structure or any part thereof by pre-planned and controlled manner" (Patel, Jayeshkumar, & Bhavsar, 2015). Rathi and Khandve (2014) also describe demolition as the process of destroying down or dismantling or collapsing down of large buildings after its useful life period. Jalandar et al. (2014) also define building demolition as a means of destroying down or pulling down a building with the help of equipment's, machineries explosives or with manual techniques without affecting the surrounding. It is the complete or partial dismantling of a structure. It excludes refurbishment, provided the work does not involve the alteration of existing structural components. Hence, demolition is carried out either manually or mechanically using large hydraulic equipment: elevated work platforms, cranes, excavators or bulldozers (Jalandar et al., 2014).

Rodrigues (2014) opines that engineering is not only about construction but also about demolition, enabling existing space to be reused. Rodrigues (2014) further states that demolition refers to the set of removal works to be applied to an existing structure leading to new space availability. Demolition work can be partial or global and can be used on new or old structures.

Conversely, the existence of the structure after the service life period is over is very dangerous to its occupants and surrounding buildings. Hence, demolition helps to prevent the accidental collapse of any part of the building and ensures safety of people and properties within the neighbourhood (Rathi and Khandve 2014). Likewise, Andrew (2006); Khairul (2012); observes that demolition is very high risk job, complex and unique. Hence, it requires well knowledge and strict regulation and precaution measurement that must be followed to avoid any damage to human life and environment.

The process of demolition is carried out with the help of some equipment or other methods with legal procedure followed by the consent of the local authority. Rathi and Khandve (2014) outline the different steps before the start of a demolition process as follows:

i. **Surveying of site:** The two types of surveying which are mainly conducted are building surveying and structural surveying.
ii. **Removal of hazardous materials:** Before starting demolition of building, hazardous materials if any, such as asbestos containing materials, petroleum contamination and radioactive contamination, etc. exist in the building are removed.

iii. **Preparation of plan for demolition work:** Demolition Plan and strategy is prepared which includes the following:
    a. The building location to be demolished.
    b. Topography of the site with its ground level contours and sections of the slopes and ground supported by the building where appropriate
    c. Details of ground removal and/or backfilling.

iv. **Required stability report:** The stability report shall include the following parts:
    a. A report on the stability of the building to be demolished during all stages of demolition.

b. In the case when powered mechanical plants or equipment are used, structural calculations for all temporary supports and bracings.
c. A report on the stability of neighbouring buildings, adjoining properties

In addition to this, Rathi and Khandve (2014) opine that demolition work is one of the most important operations in construction engineering field. If demolition activity is not done carefully it may result into severe consequences as: -

i. Injury to human workers due to the difficulty of accessing into or working inside a building which is under demolition.
ii. Falling of smaller objects or debris from the demolishing building.
iii. Falling of partially demolished structure.
iv. Collapse of unstable structure due to original structure being disturbed.
v. Employing inappropriate methods to demolish.
vi. Collapse of heavy demolition equipment due to inadequate support of the partially demolished structure.
vii. Collapse of the partially demolished structure due to the accommodation of large amount of unclear debris.
viii. Congested site environment that easily cause damages to human workers or to the third parties that are situated nearby the demolition site.
ix. Difficult access for workers entering into a building under demolition
x. Heavy machinery used in demolition may have risk of collapse due to insufficient support.

To avoid these consequences from demolition work, Rathi and Khandve (2014) stress that it is necessary to understand complete process of demolition of building.

Building Demolition and Implosion Demolition Method

According to Amrutha and Vasudev (2014), implosion is the term that was coined in the late 1950s to describe the process of using the minimum amount of explosives with minimal structural preparation expense to get a structure to collapse in a controlled fashion. Jalandar et al. (2014) describe implosion as an event where something collapses inward, because the external atmospheric pressure is greater than the internal pressure. For example, if we pumped the air out of a glass tube, it might implode. This method of building demolition does not rely on the difference between internal and external pressure to collapse a structure but weakens or removes critical supports such that the building can no longer withstand the force of gravity and falls under its own weight. Generally, it is adopted for high rise buildings in urban areas, where other demolition methods are not acceptable.

Explosive demolitions consist of using controlled explosives by placing small explosive charges (generally less than 50 g), which are usually placed in the structural elements that are to be demolished and confined to drillings made for this purpose (Gomes, 2010). After this placement the charges are detonated through an initiation system. The explosive charges present in the vertical elements detonate, causing a “structural vacuum” called a demolition belt, within which through gravity the structure collapses, fragmenting due to its own weight, or, when appropriate, enabling it to fall on one side, enabling easier access to the debris which can then be taken apart using traditional methods (Gomes, 2000).

The use of explosive demolitions has grown over the years, not only in building demolition but with other types of structures like metal or reinforced concrete structures as well. Considered to be a fast, practical and economical alternative to traditional demolitions, its main focus is the use on large structures such as sky-scrapers, chimneys, and silos, large solid reinforced concrete structures like naval infrastructure foundations, and even the quick demolition of bridges (Gomes, 2010). The basic idea of explosive demolition is quite simple if

the support structure of a building at a certain point is removed, the section of the building above that point will fall down on the part of the building below that point. If this upper section is heavy enough, it will collide with the lower part with sufficient force to cause significant damage. The explosives are just the trigger for the demolition. It's gravity that brings the building down.

Methodology

This study was carried out Onitsha metropolis of Anambra State, Nigeria. Onitsha metropolis is made up of two Local Government Areas- Onitsha North and Onitsha South Local Government Area. It is a city located on the eastern bank of the River Niger and lies within Latitude 6° 10' 0" North and Longitude 6° 47' 0" East. It is the commercial hub of Anambra State with an estimated population of about 511, 000 based on the (National Population Commission (NPC), 2006). Onitsha metropolis is still evolving and host lot of construction activities and aged buildings that have exhausted their functional life-spans. It has been observed that majority of the buildings in the metropolis are multi-storey structures. However, many of the buildings are developed illegally; this has resulted in slums. In order to address these challenges both government institutions and individuals embark on demolition works.

The target population of the study comprises of all managing directors of building construction firms in Onitsha Metropolis and the Director of Urban Planning of Onitsha North and Onitsha South Local Government Councils of Anambra State. There are 86 registered construction companies in the Onitsha. Whereas the Anambra State Physical Planning Board has 2 directors. Hence, the population comprised 88 respondents.

Accordingly, the Taro Yamane's formula (Yamane, 1967) was used to determine the sample size as follows:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where: N = population size
n= Desired sample size
e = level of significance
1 = Unity

The population is 88 and level of significance is set at 0.05 (95% confidence internal) the sample size can be computed as follows:

$$n = \frac{88}{1+88(0.05)^2}$$

$$n = 72$$

The desired sample size (n) = 72. Hence, a total of seventy-two (72) were administered to the respondents. The whole questionnaire administered were all properly filled and returned. This represents a return rate of 100%. Data collected from the questionnaire survey and interviews was subjected to descriptive analysis using tables and percentages, mean and standard deviation.

Mean score index was used to rank all the options provided based on the five point Likert scale while Standard deviation was used to ascertain the variance of the responses on each of the variable examined.

Mean score index is given as:

$$MS = \frac{\sum fx_i}{N} \quad (2)$$

Where: MS = Mean score of each variable
F = Frequency of the response to each variable
X_i = Score or ranking given to each variable
N = Total number of responses.
Results are accepted when calculated mean is 3.00 and above

Standard Deviation (S.D) is given as:

$$S.D = \sqrt{\frac{\sum (X - \dot{X})^2}{N}} \quad (3)$$

Where: S.D = Standard deviation of a sample,
$\sum$ means "sum of"
X = each value in the data set
$\dot{X}$ = mean of all values in the data set,
N = number of values in the data set

RESULTS AND DISCUSSION

Table 1. Reasons for building demolition in the study area.

s/n	Reasons for Demolition	5	4	3	2	1	N	- X	StD	Rank
1	Non-adherence to regulations	25	22	16	6	3	72	3.83	1.13	1st
2	Natural/ man-made disaster	14	25	22	6	5	72	3.51	1.11	2nd
3	Conversion of use	9	14	26	19	4	72	3.06	1.09	3rd
4	Exhaustion of Building life-span	3	4	25	29	11	72	2.43	.9	4th

Source: Researchers' Fieldwork (2017)

Table 1 shows that the most prevalent reason for building demolition in the study area is non-adherence to regulations (Mean = 3.83). This was followed by natural/man-made disasters (Mean = 3.51) and conversion of use (Mean= 3.06). However, that building demolition are undertaken due to the exhaustion of building life span has the least mean from respondents' responses (Mean= 2.43).

The above results agree with the assertion of Rodrigues (2014) that buildings considered for demolition are those that do not adhere to regulations, have faced disasters and/or need conversion. Rathi and Khandve (2014) elaborated that during conversion of use partial demolition takes place. This is to allow for the extension of the building.

Table 2. Methods of Building Demolition Employed in the Study Area

s/n	Building Demolition Methods	5	4	3	2	1	N	X	StD	Rank
1	Hand Demolition	45	25	2	0	0	72	4.60	0.55	1st
2	Heavy Machinery Razing Operation	36	22	9	5	0	72	4.24	0.93	2nd
3	Pressure Bursting	0	0	4	18	50	72	1.36	0.59	5th
4	Dismantling	4	11	29	14	14	72	2.68	1.12	4th
5	Mechanical	14	29	18	4	7	72	3.54	1.16	3rd
6	Implosion (Explosive)	0	0	0	7	65	72	1.10	0.30	6th

Source: Researchers' Fieldwork (2017)

Results from Table 2 reveals that hand demolition method with a Mean of 4.60 is the most utilized method of demolition in the study area. Its Standard Deviation of 0.55 suggests that its acceptance is unanimous. Other methods employed in the study area include: heavy machinery razing operation with a Mean of 4.24 and mechanical demolition method with a Mean of 3.54. Nevertheless, the use of dismantling method (Mean= 2.68), pressure bursting method (1.36) and imploding (explosive) method (Mean= 1.10) were generally rejected.

The above findings align with Khairul (2012) as reviewed in the literature that manual and mechanical method of building demolition are predominant in countries like Nigeria. Also, Idris (2017) opines that imploding building demolition method is not encouraged due to the high incident of terrorism.

Table 3. Factors affecting the use of imploding methods of building demolition

s/n	Factors	5	4	3	2	1	N	$\dot{X}$	StD
1	Lack of technical expertise	37	29	4	2	0	72	4.40	0.73
2	Unavailability of explosive in the open market	27	25	20	0	0	72	4.09	0.81
3	Government stringent rules and regulations on explosives	18	30	11	7	6	72	3.65	1.20
4	Lack of Awareness	29	32	3	7	1	72	4.13	0.98

Source: Researchers' fieldwork (2017)

Table 3 reveals the factors that affect the use of Imploding method of building demolition in the study area. Results show that lack of technical expertise (Mean= 4.40) ranked highest with Standard Deviation of 0.73. This was followed by lack of awareness (Mean= 4.13), unavailability of explosive in the open market (Mean= 4.09) and government

stringent rules and regulations on explosives. The Standard Deviation of these factors which is within 0.73 and 1.20 indicates that there were very little discrepancies among the assertion of the respondents.

Based on the reviewed literature, the above findings corroborated with Onoja (2013) who observes that imploding method of building demolition is not utilized rather emphasizes are only placed on improvised explosive devices (IED) and terrorism. Consequently, National Security (2017) notes that explosive technical expertise is only seen in the military sector, procurement of explosive materials becomes stringent which make it unavailable in open market. Thus, demolition specialists are not encouraged to explore these explosives devices for implosion of buildings (Onoja, 2013).

Table 4. Strategies for improving imploding methods of building demolition

s/n	Ways	5	4	3	2	1	N	X̄	StD
1	Public enlightenment on the use of explosives for building demolition	41	29	2	0	0	72	4.54	0.56
2	Provide professional trainings for demolition specialist	40	25	4	3	0	72	4.42	0.78
3	Establish Implosion department at every military base for such services	29	25	11	4	3	72	4.01	1.08

Source: Researchers' fieldwork (2017)

Results from Table 4 indicate that the use of Imploding method of building demolition could be improved within the study area. Firstly, it was unanimously accepted (St.D= 0.56) that public enlightenment on the use of explosive for building demolition should be promoted (Mean= 4.54). Secondly, it was accepted that professional trainings for demolition specialist should be provided (Mean= 4.42). Thirdly, the respondents accepted that implosion building demolition department should be established at every military base (Mean= 4.01).

The above findings is in line with UNIDR (2015) that for the use of imploding method of building demolition to be encouraged, there must be public enlightenment campaign and the military sector need to be diversified in the use of IEDs. In addition to this, Idris (2017) submits that institutions and curriculum for demolition specialists should be established to promote imploding methods.

CONCLUSION AND RECOMMENDATIONS

From the foregoing, the study is inclined to conclude that building demolition is undertaken by professionals in Onitsha metropolis. Hand/manual method, heavy machinery, razing operation and mechanical demolition method are prevalent in Onitsha metropolis; however, other methods such as pressure bursting and dismantling methods are not recognised in the study area. In Onitsha metropolis, the imploding method of building demolition is affected by lack of technical expertise, low level of awareness, unavailability of explosives in the open market and government stringent rules and regulations on explosive.

Based on the findings, the following recommendations are made:

- Demolition specialists in Onitsha metropolis should be trained on the use of Imploding method of building demolition.

- There should be an implosion Department in military bases. This will curtail the abuse of imploding devices thereby improving security. Besides, anyone who intends to use imploding device for demolition must be licensed by the Defence Ministry to ensure security.
- Public awareness programme on the use of imploding method should be promoted in Onitsha metropolis.
- A course on Demolition Methodology" should be introduced in Building Departments of higher institutions offering the discipline to equip undergraduates early enough with the skills needed to handle imploding methods properly, should the need arise during their practice.

REFERENCES

Amrutha, M. A., & Vasudev, R. (2014). Demolition of Structures Using Implosion Technology. *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 3, Special Issue 5, Retrieved from www.ijirset.com

Andrew, E. N. (2006). Progressive Collapse- An implosion contractor's stock in trade, *Journal of Performance of Constructed Facilities,* 9, 391-402.

Gomes, G. J. (2010). Technical manual of demolition by explosive methods (in Portuguese). Lisboa: Academia Militar.

Idris, S. (2017). U.S. donates demining and explosive ordinance disposal training equipment. diplomacy international News, March 16 2017. Retrieved from www.nta.ng

Izueke, E.M. & Eme, I.O. (2013). Urban Planning in Nigeria, a Case Study of Onitsha metropolis of Anambra State. *Singaporean Journal of Business Economics and Management Studies*, 1 (12)124 – 136. Retrieved from www.singaporeanjbem.com

Jalandar, K.P., Kanade, G.N, & Kulkarni, S.S. (2014). Demolition of structure using implosion technology and reuse waste - A case study. *International Journal of Advanced Engineering Research and Studies*. Retrieved from www.technicaljournalonline.com

Khairul, F. S. (2012). Case Study: Demolition Practice of Old Mara Building On Lot 1767, Lot 1218 and Pt 4, Section 46, Mukim Bandar Kuala Lumpur, Jalan Tuanku Abdul Rahman. (Unpublished final year project, for the award of the Degree of Bachelor of Civil Engineering), Kolej Universiti Kejuruteraan & Teknologi Malaysia

Kio-Lawson, D., Duru,M. N, John, B. D., & Eebee, A.L. (2016). The Challenge of Development Control in Nigerian Capital Cities - A Case of Some Selected Cities in the Niger Delta. *Developing Country Studies*. 6 (2). 112 – 120. Retrieved from www.iiste.org

National Assembly. (2009). Explosives Act (Repeal and Re-enactment) Bill, 2009. Retrieved from www.nass.gov.ng/document/download/1163

National Population Commission. (2006). *Federal Republic of Nigeria Official Gazette,* 96(2) B, 923). Abuja: Federal Government Printer.

National Security (2017). Guidelines for Procuring Explosives and explosive Devices,. Retrieved from http://euc.nsa.gov.ng.

Ogundele, F. O., Ayo, O., Odewumi, S. G. & Aigbe, G. O. (2011). Challenges and prospects of physical development control: A case study of Festac Town, Lagos, Nigeria. *African Journal of Political Science and International Relations.* 5(4), 174-178, Retrieved from http://www.academicjournals.org/ajpsir.

Olajumoke, A.M., Oke, I.A., Fajobi, A.B., & Ogedengbe, M.O. (2009). Engineering failure analysis of a failed building in Osun State Nigeria. *J. Failure Anal. Prev.* 9, 8–15.

Onoja, N. (2013). Federal government reviews use of commercial explosives. Feb. 26 2013. Retrieved from www.vanguardngr.com

Patel, P., Jayeshkumar, P., & Bhavsar, J.J. (2015). Demolition: methods and comparision. *Proceedings of the International Conference on Engineering: Issues, opportunities and Challenges for Development".* Patel Institute of Technology and Research Centre, Umrakh, Bardoli. Retrieved from https://www.researchgate.net/publication/281174903

Rathi, S. O., & Khandve, P.V. (2014). Demolition of Buildings – An Overview.*International Journal of Advance Engineering and Research Development (IJAERD,* 1(6)234 – 241. Retrieved from www.ijaerd.com

Rodrigues, D. J. B. (2014). Controlled demolition of reinforced concrete buildings by the use of explosives. The armed forces hospital building, C5 case study. Retrieved from www.exercito.pt/sites/recrutamento

Tah, J.M.H. (2006). The role of the African Diaspora in Sustainable Homebuilding. In *Proceedings of the African Diaspora Conference*; in Nwana, H.S., Tah, J.H.M, (Eds.); London, UK: 22 July 2006; pp. 18–26.

United Nations Institute for Disarmament Research-UNIDR (2015). *Addressing Improvised Explosive Devices Options and Opportunities to Better Utilize UN Processes and Actors*. Retrieved from www.unidir.org

Yamane, T. (1967). Statistics: *An introductory analysis* (2nd ed.). New York: Harper and Row.