Available online www.jsaer.com

Journal of Scientific and Engineering Research, 2023, 10(2):150-155

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Investigation on the Actual Behaviour of a Reinforced Concrete Beam Occasioned by Abandonment

John A. TrustGod*, Joshua Douye, Orumu S. Teminusi

Department of Civil Engineering, Niger Delta University Wilberforce Island, Nigeria
johteskconzults@gmail.com

Abstract This paper presents the results of an investigation into the actual behavior of a two-layer reinforced concrete beam occasioned by abandonment. Six (6) RC beams of 1100 x 100 x 150 mm, provided with 2ϕ10 and 2ϕ8 at the bottom and top, respectively, and ϕ6 mm at 225 mm spacing, were used as links. The beams were constructed with a 1:2:4 mix ratio and a 0.54 water-to-cement ratio. Two beams were used as control and were constructed with a single concrete layer, while the remaining beams were produced to different depths and abandoned for 28 days before being completed. All beam specimens were statically loaded on a 20-ton capacity loading frame to assess load-carrying capacity and resistance to deformation under applied load. The results show that abandonment has no adverse effect on the general performance of reinforced concrete beams. The abandoned concrete at the bottom fiber of the reinforced concrete beam contributes significantly to the general performance of the reinforced concrete beam. The abandoned reinforced concrete beams with an initial abandoned concrete layer depth at the neutral axis or above exhibited a better stiffness. Every specimen showed an initial rigidity until the first crack was observed and the rigidity of the specimen gradually reduced.

Keywords Abandonment, Bending, Flexural rigidity, Shear, stiffness

Introduction

The construction section performs a substantial function in the development of any country [1, 2], as they are involved in the construction of roads, bridges, houses, and other engineering structures. However, it is not unusual for construction projects to be abandoned. A project is a brief endeavor having a start and an end (often time-limited and frequently bound by financing or deliverables), undertaken to fulfill specific aims and objectives, typically to bring about positive change or added value. Construction project abandonment is the refusal, rejection, unwillingness, or failure to complete a construction project before an acceptable time [3, 4, 5]. Abandoned construction projects are seen all across Nigeria, with the expectation that they will be completed at later times. Many construction projects remain unfinished at various phases of development and incur significant losses. Construction project abandonment is not unique only to Nigeria, as it is present in other countries, [6, 7]. The factors that significantly contribute to construction project abandonment include incompetent contractors, defective design, nonfunctional government policies, inadequate funding, improper planning, politics, inflation, and corrupt practices, among others [8, 9, 10]. One of the best-known abandoned projects in Bayelsa State is the Bayelsa Tower Hotel, located in Yenagoa, the capital of Bayelsa State. Project abandonment also results in the waste of equipment and materials on-site and an increase in the final cost of the project [11, 12]. According to Shetty [13], when a project is abandoned, the structural members, such as slabs, beams, and columns, deteriorate with time. When concrete loses its bond with steel reinforcement bars, its strength suffers, and the rebar rusts. When the strength of concrete on a reinforced concrete member has degraded, it reduces the load-carrying capacity of the structural member, which is unsafe for engineering practice. Concrete becomes stronger as it continues to hydrate. With concrete, the rate of strength gain increases first more quickly and then decreases over time. It is common practice to consider concrete's 28-day strength to be its full strength. In reality, concrete continues to gain strength after 28 days. Nigeria has become the "world's graveyard of abandoned projects," with project losses totaling trillions of naira. It seems impossible that Nigeria, a nation with great potential in the building and construction industry, should experience such a high rate of project cancellation. The Federal Government of Nigeria has about 4000 incomplete or abandoned projects, with a total estimated cost of more than N300 billion, according to Kotangora [14]. It will take at least 30 years to complete these projects with the government's present level of project execution capabilities. He said that because the problem of abandonment has not received adequate attention for too long, it is now having a multiplier effect on the economy of the country as a whole and the building industry in particular.

In reality, project abandonment has certain negative effects on the general people and the environment. Hussain [15] claims that abandoned projects are viewed as a channel through which Nigerian resources are wasted without the benefit of the people. Furthermore, Okonkon [16] stated that abandonment resulted in the waste of public resources and money. Projects started by the previous administration are abandoned when a new one comes into power, and new ones that might not be finished are started instead. As a result, there are perpetually abandoned projects everywhere.

Construction project abandonment as shown in Figure is a menace that has plagued the construction industry in Nigeria. With all the states suffering from construction project abandonment, there is a need to understand the structural implication of abandonment on structural members. However, several studies have been done relating to construction project abandonment and its social and economic effects, including environmental effects [17, 18]. However, the actual structural response of a reinforced concrete (RC) beam caused by abandonment has not been thoroughly investigated. It is in this view that the research was carried out to assess the actual structural response of an RC beam occasioned by abandonment by using a model in the laboratory.

Figure 1: Abandoned RC members

Materials and Method

Six (6) RC beams of 1100 x 100 x 150 mm, provided with 2Y10 and 2Y8 at the bottom and top, respectively, and R6 mm at 225 mm spacing, were used as links. The beams were constructed with a 1:2:4 mix ratio and a 0.54 water-to-cement ratio. The various beam types are RF1, RF2, D1, D2, D3, D4, and D5. The beam types RF1 and RF2, which were used as control beams and constructed with a single concrete layer as shown in Figures 2a and 2b, examined the bending and shear strengths at 28 and 56 days, while beam types D1, D2, D3, D4, and D5 were constructed to different depths and abandoned for 28 days before being completed after 28 days.

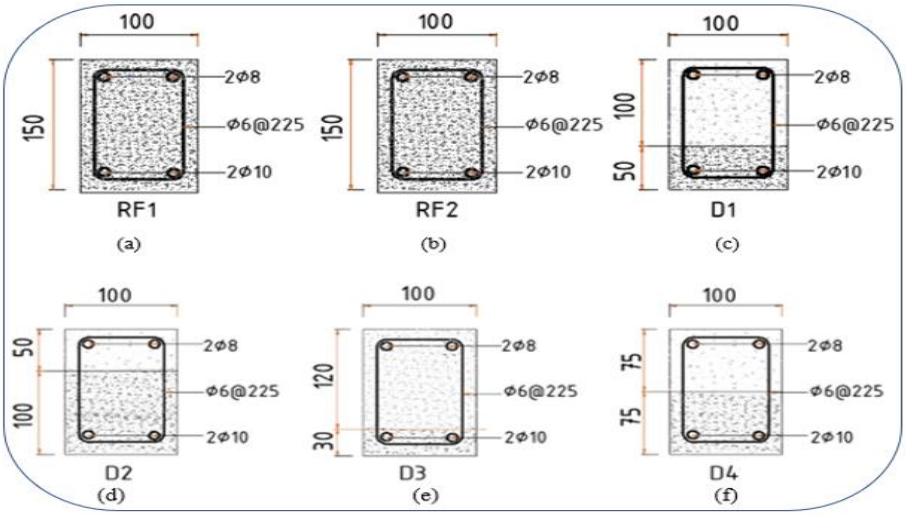

Figure 2: Beam configurations

The beam type D1 was cast to a depth of 50 mm, which is 33.33% of the overall beam depth, and was abandoned for a period of 28 days, the remaining 100 mm, making up 66.67% of the depth, was cast after 28 days of abandonment, as shown in Figure 2c. The beam type D2 was cast to a depth of 100 mm, which is 66.67% of the overall beam depth, and was abandoned for a period of 28 days, the remaining 50 mm, making up 33.33% of the depth, was cast after 28 days of abandonment, as shown in Figure 2d. The beam type D3 was cast to a depth of 30 mm, which is 20% of the overall beam depth, and was abandoned for a period of 28 days, the remaining 120 mm, making up 80% of the depth, was cast after 28 days of abandonment, as shown in Figure 2e. The beam type D4 was cast to a depth of 75 mm, which is 50% of the overall beam depth, and was abandoned for a period of 28 days, the remaining 75 mm, making up 50% of the depth, was cast after 28 days of abandonment, as shown in Figure 2f. The beam type D5 was cast to a length of 550 mm, which is 50% of the overall beam length, and was abandoned for a period of 28 days. The remaining 550 mm, making up 50% of the length, was cast after 28 days of abandonment. All beam specimens were statically loaded on a 20-ton capacity loading frame to assess load-carrying capacity and resistance to deformation under applied load.

Results and Discussion

The results of the investigation of the actual behaviour of a two-layer reinforced concrete beam occasioned by abandonment have been presented and discussed in detail in this section. Seven RC beams were studied under a one-third-point loading application. Beam types FR1 and FR2 were chosen as control beam and was compared to beams D1, D2, D3, D4, and D5. The crack pattern of RF1, RF2, D1, D2, D3, D4, and D5 are given in Figure 5. The failure load against the sample types and load-deformation responses for the beams are shown in Figures 3 and 4, respectively. Table 1 presents the yield load, deflection, and failure load, while Table 2 shows the flexural rigidity of the beams.

Table 1: Test results

Beam Type	Yield Load (kN)	Deflection at yield load (mm)	Failure Load (kN)	Deflection at Failure (mm)	Mode of Failure
RF1	29.43	4.53	39.24	6.69	Flexure/shear
RF2	37.28	6.5	43.2	7.08	Flexure/shear
D1	29.43	5.41	41.71	9.38	Flexure/shear
D2	39.24	5.51	49.11	8.56	Flexure/shear
D3	29.43	5.49	41.24	9.04	Flexure
D4	39.24	5.97	47.8	8.08	Flexure/shear
D5	39.24	6.71	49.68	8.27	Flexure

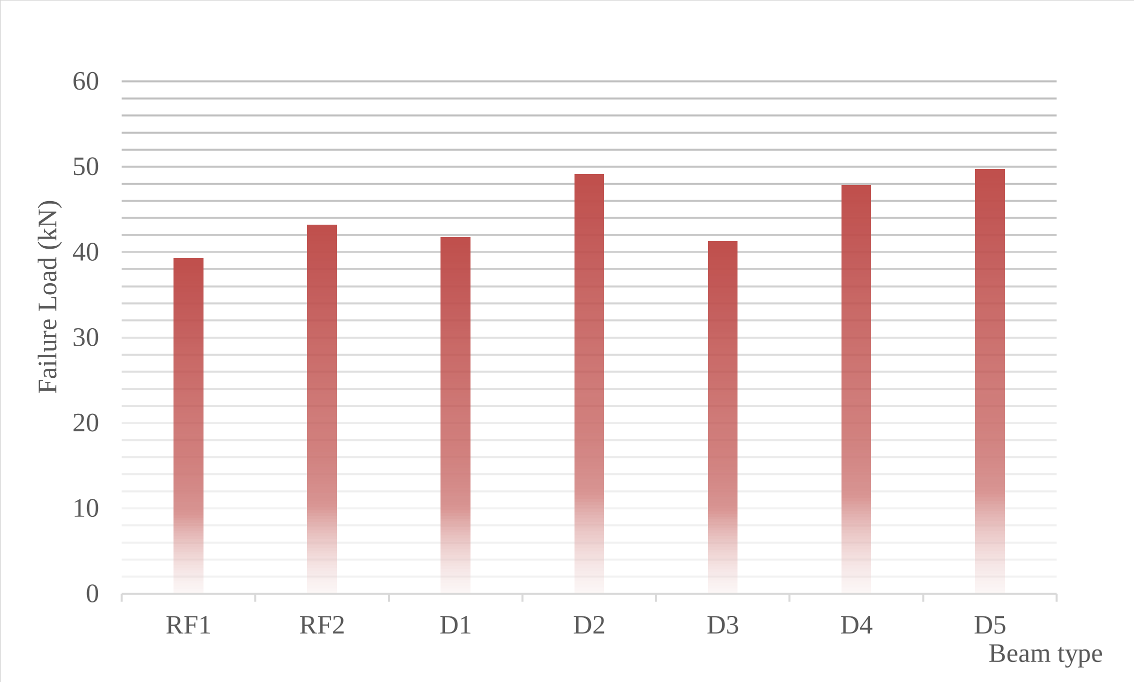

Figure 3. Failure load versus Beam type

Load Capacity

The ultimate failure load of the control beams, RF1 and RF2, is less than beams D2, D4, and D5, as shown in Table 1 and Figure 3, but RF2 is higher than D1 and D3. The beams D2, D4, and D5 had a higher load-carrying capacity (LCC) than RF1 and RF2 by 25, 22, 27, and 14, 11, and 15%, respectively, as given in Figure 3 and Table 1.

According to the results in Table 1, the beams failed primarily due to flexure and shear. For samples RF1, RF2, D1, D2, and D4, the failure mode was observed to be the same in the laboratory. The flexural failure of these beams was observed when the applied load on the beam exceeded its flexural strength and the concrete on the tensile zone of the beam cracked and gradually developed along the span of the beam until subsequently, the applied load on the beam also exceeded the shear strength of the beam and cracks were observed at the supports of the beams. Beam type D2, which had an abandoned depth of 100 mm, is stiffer than samples D1, D3, and D4. However, the reason some of the abandoned beams perform better than the control beams may be due to their water absorption rate or hydration rate.

Table 2: Flexural rigidity at failure; EI = 23PL3/648δ

Beam Type	Failure load (N)	Deflection at Failure load (mm)	Beam length (mm)	Flexural Rigidity (Nmm2)
RF1	39240	6.69	1100	2.8 x 1011
RF2	43200	7.08	1100	2.9 x 1011
D1	41710	9.38	1100	2.1 x 1011
D2	49110	8.56	1100	2.7 x 1011
D3	41240	9.04	1100	2.2 x 1011
D4	47800	8.08	1100	2.8 x 1011
D5	49680	8.27	1100	2.8 x 1011

Load-deformation

Load-deflection behaviour graph is one of the tools used in studying the structural behavior of beam element and is presented in Figure 4, which reveal that beam, type D1, was significantly stiffer than beams RF1, RF2, D2, D3, D4, and D5. However, D2 is stiffer than RF1, RF2, D3, D4, and D5.

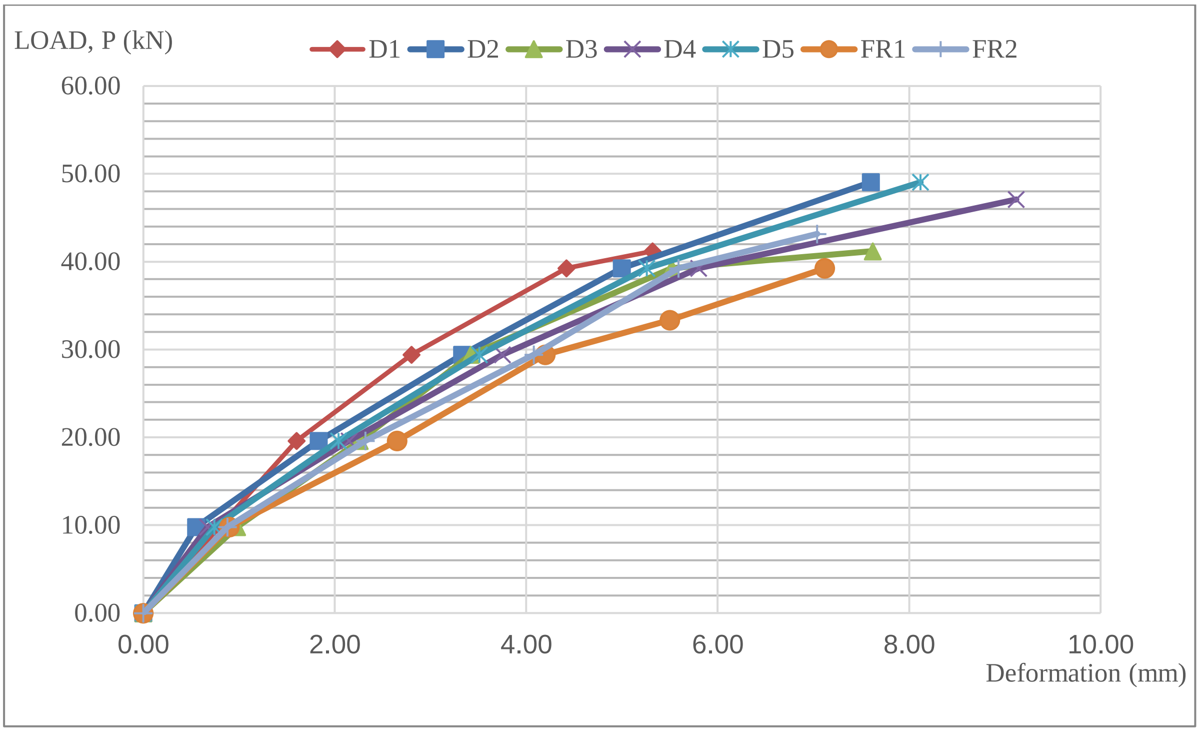

Figure 4: Load-deflection response

The deflections of the beam RF1 at failure were lower than all the beams., which were abandoned for 28 days. The highest deformation was seen in beam D4 with an abandoned layer of 75 mm. Beams RF1, RF2, D1, D2, D3, D4, and D5 have a maximum deflection of 6.69, 7.08, 9.38, 8.56, 9.04, 8.08, and 8.27, respectively. Table 2 showed the flexural rigidity of RF1, RF2, D1, D2, D3, D4, and D5. Flexural rigidity is characterized as the resistance offered by the structural element when bent. It is clear that D1 and D3 have the lowest flexural rigidity, which indicates that they can resist bending more than the other beam types. The crack patterns are shown in Figure 5.

Figure 5: Crack pattern

Conclusion

The experimental investigation of the actual behaviour of a two-layer reinforced concrete beam occasioned by abandonment has been examined and below are the conclusions:

1) The test results show that abandonment has no adverse effect on the general performance of reinforced concrete beams.
2) The abandoned concrete at the bottom fiber of the reinforced concrete beam contributes significantly to the general performance of the reinforced concrete beam.
3) The abandoned reinforced concrete beams with an initial abandoned concrete layer depth at the neutral axis or above exhibited a better stiffness.
4) Every specimen showed an initial rigidity until the first crack was observed and the rigidity of the specimen gradually reduced.

References

[1]. Olalusi, O. and Otunola, A. (2012). Abandonment of Building Projects in Nigeria -A Review of Causes and solutions. International Conference on Chemical, Civil and Environment Engineering, 24-25.

[2]. Yap E. H, (2013). Causes of Abandoned Construction Projects in Malaysia. A thesis submitted to the Department of Surveying, Faculty of Engineering and Science, University Tunku Abdul Rahman, in partial fulfillment of the requirements for the degree of Master of Science in Construction Management.

[3]. Okafor F. O., Osadebe N. N. and Sylvester, I. J. (2018). Abandoned Projects-Implication on The Strength of Exposed Steel and Concrete in The Southern Region of Nigeria. Nigerian Journal of Technology (NIJOTECH), 37(3), 562 – 569.

[4]. Ariffin, N. F., Ali, M. I., Ramli, N. I., Jaafar, M. F., Ahmad, S. W., Abdul Shukor, N. H. L. and Abd Khalid, N. H. (2013). The Study on Cause and Effect of Abandoned Housing Project in Selangor. 14th International Conference on Concrete Engineering and Technology.

[5]. Samantha T and Wallace J. (2013) "Data-driven organizing: A Community-University partnership to address vacant and abandoned projects", Journal of Community Practice, 21 (3), 248-262.

[6]. Hicks, M., (2008) United States, Real Estate, Contract, Project Abandonment: Separate Legal Concepts. Available at: http://www.mondaq.com/unitedstates/article.asp?articleid=60362

[7]. SPIEGEL (2009). Architecture's Reality Check: Global Downturn Dooms Prestige Construction Projects. SPIEGEL ONLINE International.

[8]. Ayodele E. O. and Alabi, O. M. (2011) "Abandonment of construction projects in Nigeria", Journal of Emerging Trends of Economics and Management Science 2 (2), 142-145.

[9]. Khalid, M.S. (2010). Abandoned Housing Development: The Malaysian Experience. Ph.D. Edinburgh: Heriot-Watt University.

[10]. Dahlan, N.H.M., (2010). Abandoned Housing Projects in Peninsular Malaysia: Problems and Suggestions. In 2nd International Conference on Arab Malaysian Islamic Global Business Entrepreneurship 2010.

[11]. Chow, B. (2009). Buyers of the abandoned project need help. The Star Online. Available at: http://thestar.com.my/metro/story.asp?file=/2009/2/28/central/3355440&sec=central

[12]. Chan, L.L., (2009). Low-cost housing project abandoned after 90% completed. The Star Online. Available at: http://thestar.com.my/news/story.asp?file=/2009/8/6/nation/4463859&sec=nation.

[13]. Shetty M.S. (2008) Concrete Technology: Theory and Practice, S. Chand & Company.

[14]. Kotangora O. O. (1993), Project Abandonment, Nigerian Tribune, 5-6.

[15]. Hussain O., (2017) "Disastrous Effect of Abandoned Projects in Nigeria", www.naija.ng/436964.

[16]. Okonkon U (2011). The effect of abandoned projects and programs by the successive government on the materials economy - Nigerian Commentaries FRCN.

[17]. Dumo Mac-Baranga, (2017) "Construction Project Abandonment: - An Appraisal of causes, Effect and Remedies", World Journal of Innovation and Modern Technology, 1(1), 34-44.