Seismic Retrofitting: A preparatory approach against the forecasted quakes in the South-Western Part of Nigeria.

Seismic Retrofitting: A preparatory approach against the forecasted quakes in the South-Western Part of Nigeria.

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Abstract. The seismic record of Nigeria shows the occurrences of quakes that range from small to medium magnitude as against the belief of some people that Nigeria is aseismic. Researchers in Nigeria have also recently raised alarm that devastating earthquake is likely to be experienced in the nearest future with attention drawn to the south west in Nigeria. The historical seismic data as published in this work had the sizes of quakes presented using the intensity scale. To further give us clarity into the actual sizes of the documented quakes, the intensities were converted to local magnitudes, hence the minimum and maximum quakes ever witnessed in Nigeria were ascertained to be 3.3Ml and 6.5Ml. In response to the seismic alerts and forecast results targeted at the south-west region of Nigeria, seismic retrofitting is recommended for the existing structures along the seismic fault in the south west while the response results published in the works of [1] is recommended as guides to the designs of subsequent structures along the fault in the south west so as to establish safety just if the forecasted quake is experienced.

Keywords: Tremors, Seismic Retrofitting, Earthquake Forecast, Seismicity, Earthquake.

1. Introduction

Nigeria has been argued to be aseismic by many for several years until some earth shakings of average intensities began to call for attention into the aseismic claimed nature of Nigeria. As against the beliefs of many that Nigeria is not listed among the seismic prone nations of the earth, the tremors in some regions of Nigeria have suggested a change in the acclaimed belief [2]. The seismic record of Nigeria shows several quakes in many regions in Nigeria as presented in the table 1. Nevertheless, many other shakings have also occurred without adequate record. According to [3], bulk of the quakes that occurred without proper record was due to the inadequacies of the seismic recording stations in Nigeria. Hence, more seismic recording stations are necessary to combat the seismic recording issues that have lingered for so long [3].

Table 1: History of Earthquake Events in Nigeria

S/N	Date	Place of Occurence	Magnitude (Ml)	S/N	Date	Place of Occurence	Magnitude (Ml)
1	1933	Warri		19	1990-04-05	Jerre	4.6
2	1939-06-22	Lagos, Ibadan, Ile-Ife	6.5	20	1994-11-07	Ojebu-Ode	4.2
3	1948-07-28	Ibadan		21	1997	Okitipupa	4.2
4	1961-07-02	Ohafia		22	2000	Edo	4.5

5	1963-12-21	Ijebu-Ode	4.6	23	2000-08-15	Jushi-Kwari	3.7
6	1981-04-23	Kundunu	3.7	24	2000-03-13	Benin	4.2
7	1982-10-16	Jalingo, Gembu	3.7	25	2000-03-07	Ibadan, Akure, Abeokuta, Ijebu-Ode, Oyo	4.7
8	1984-07-28	Ijebu-Ode, Ibadan, Shagamu, Abeokuta	5.1	26	2000-05-07	Akure	4.2
9	1984-07-12	Ijebu Remo	4.2	27	2001-05-19	Lagos	4.2
10	1984-08-02	Ijebu-Ode, Ibadan, Shagamu, Abeokuta	4.6	28	2002-08-08	Lagos	4.2
11	1984-12-08	Yola	3.7	29	2005-03	Yola	3.7
12	1985-06-18	Kombani Yaya	4.2	30	2006-03-25	Lupma	3.7
13	1986-07-15	Obi	3.7	31	2009-09-11	Abomey-Calavi	3.3
14	1987-01-27	Gembu	4.6	32	2011-11-05	Abeokuta	4.4
15	1987-03-19	Akko	4.2	33	2016-07-10	Saki	4.2
16	1987-05-24	Kurba	3.7	34	2016-08-10	Igbogene	3.7
17	1988-05-14	Lagos	4.6	35	2016-09-11	Kwoi	3.7
18	1990-06-27	Ibadan	3.7	36	2016-09-12	Sambang Dagi	3.7

Sources: [4-5]

Some other shakings also occurred at different times but there was no record of their sizes. One of the recent tremors felt in Nigeria is that of September 7, 2018. The event took place in the city of Abuja very early in the morning at about 6:00am. Many residents of Abuja were reported to be in panic as this event might be a warning towards a future earthquake. Another source reported three events on September 5, 2018. The three events were said to have taken place on September 5, 2018 at about 4:30 pm, 6:15 pm and 8: 20pm. The three events were said to have caused shakings of buildings and with the impact felt within buildings. The shakings of September 7, 2018 was felt in Maitama and Utako. The then senate president by name Dr. Bukola Saraki was said to have posted on his social media page as regard the quakes in these words; " We have all been feeling the earth tremors in Abuja and surrounding areas over the last 48 hours. I know that many people are scared, but please, remain calm and vigilant". Despite the panic and trauma caused in the event of September 7, 2018, the size of the event is still unknown [6]. This is also the case of many other shakings felt in diiferent places at different times.

The table 1 as published by [4-5] presented the sizes of the recorded quakes using intensity scale. In this work, the equation 1 as presented by [7] was employed to convert the intensities to local magnitudes as presented in the last column of the table 1.

$$M_l = 2.381 + 0.4452I_o \quad (1)$$

The conversion was done to further express the magnitudes of each quake experienced in the different regions. The conversion carried out in this work shows that the smallest magnitude of quake ever experienced in Nigeria was 3.3 local magnitude while the largest quake ever experienced in Nigeria was 6.5 local magnitude. An earthquake that is as large as 6.5 local magnitude is expected to occur with a considerable level of damage though there is no substantial record to further give clarity on the 6.5 Ml that occurred in the south west on the 22nd of June, 1939.

2. Seismic Retrofitting

Seismic retrofitting is the process of improving, modifying or strengthening an existing structure to resist seismic activities such as tremors and quakes. Buildings can be retrofitted to resist different sizes of quakes. In the stead of collapsing and rebuilding an already existing structure, retrofitting is a good technical solution to consider.

Many buildings around the world as at the time of their design and construction were not designed with consideration to seismic activities. The lack of consideration to seismic activities could be due to many factors such as considerable low seismic activities and even lack of seismic activities. Some of these buildings that had seismic activities considered were not adequately considered. Hence, an approach to make buildings that fall into this category shaking-proof is an option to consider. Approaches to make such buildings safe in times of seismic activities might not come that easy due to the fact the buildings under consideration have already been constructed and hence rectification or modification might be tasking [10-14]. The figure 3, figure 4, and figure 5 are examples of retrofitting process.

Figure 3: Retrofitting of corroded RC columns (Source: [15])

Figure 4: Repaired web-gap view (Source: [16])

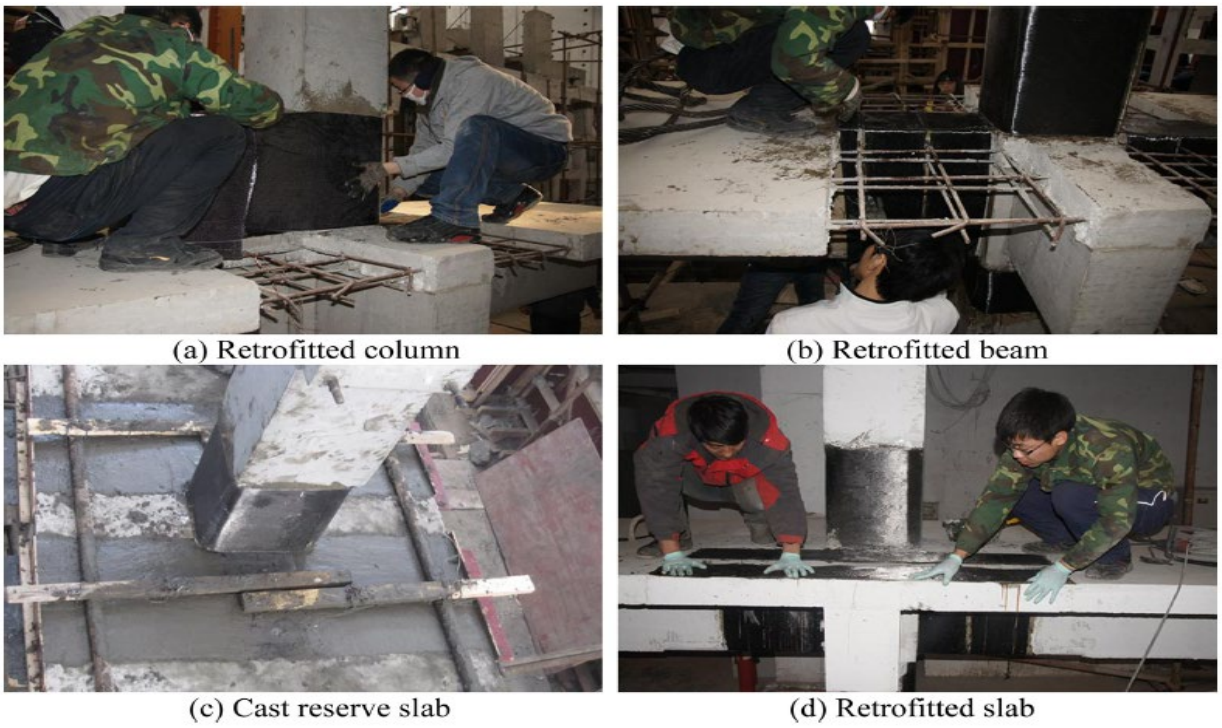

Figure 5: Retrofitting of Column, Slab and Beam (Source: [17])

The buildings around the lines of fault in Nigeria would be considered to fall into this category since they are already built and retrofitting them will infuse into them the necessary resistance needed for the forecasted quakes. Taking a seismic retrofitting approach will be more economical than the destruction and rebuild of the existing structures.

3. Quakes in the South-Western Region of Nigeria

From the Figure 1 as related by [8], all the six geopolitical zones in Nigeria have experienced shakings at different times and with different intensities.

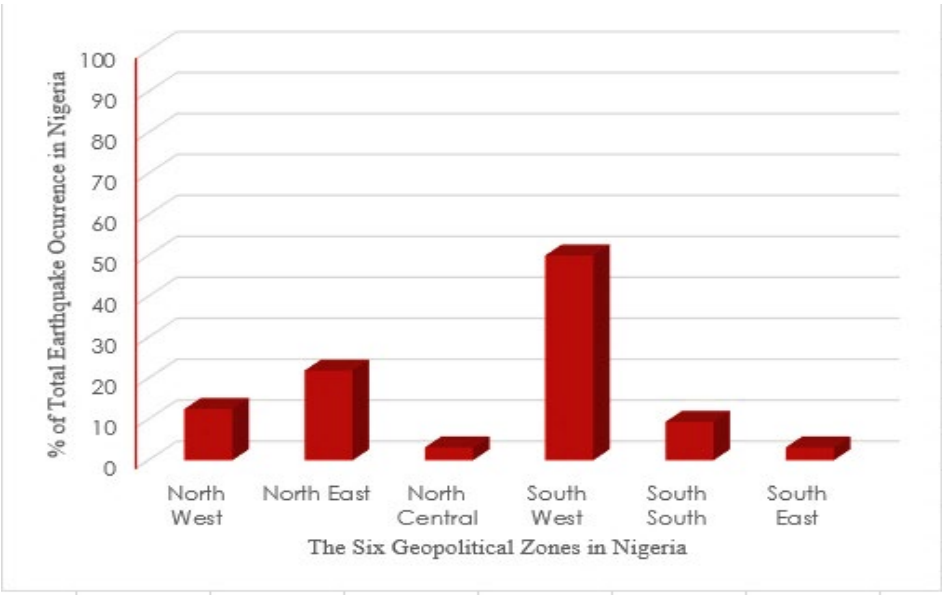

Figure 1: Seismic Regionalization of Nigeria (Source: [8])

Nevertheless, the South-West region of Nigeria has had the most seismic events in numbers as shown in the figure 1 and in magnitude as shown in the left-column of table 1. According to [8], fifty percent (50%) of all the quakes ever witnessed in Nigeria occurred in the South West. This would set a basis to consider the south west as the most seismic prone region in Nigeria. The recent seismic alerts and the concentration of seismic activities in the south-west region of Nigeria prompted the research of [9], that forecasted that an earthquake magnitude that is greater than 5Ml is likely going to occur in the south west between 2017 and 2028. His probability of forecast ranged from 6.0% to 91.1%. According to [8], the forecast of [9] is very timely and necessary but it is open ended, hence [8] further forecasted a quake that is as high as 7.2Ml with probability of occurrence to be 36.79% in the year 2028. Based on the forecast of [8], the largest quake that can ever be witnessed in the south west is the forecasted 7.2Ml. There is also a seismic fault in Nigeria called the Ifewara-Zungeru fault. The Ifewara-Zungeru fault trends through the south west in Nigeria as related in the figure 2.

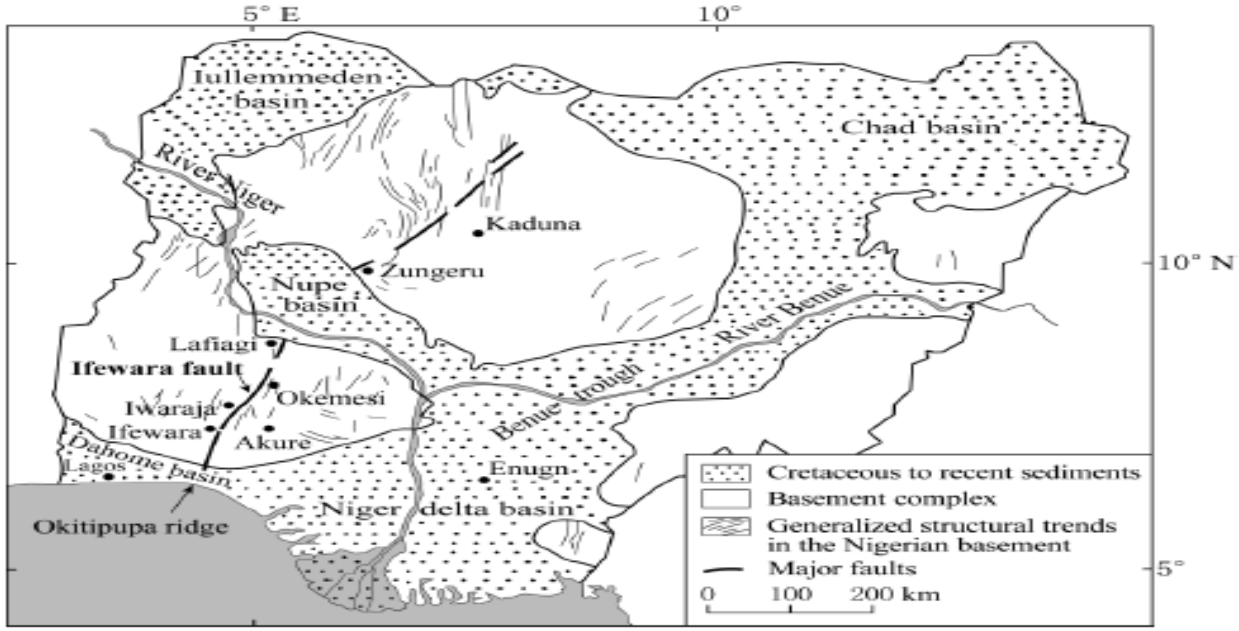

Figure 2: The Ifewara-Zungeru fault on the Nigeria Map (Sources: [4])

The fault, passing through the south-west region is probably the reason why the south west has witnessed the most of the seismic events in Nigeria.

4. Conclusions

The concentration of seismic activities in the South-West region of Nigeria shows that the area is more prone to seismic activities. The several seismic alerts and warnings from researchers in relation to the South West should be given uttermost attention by the Government of Nigeria to ensure the safety of lives and properties.

5. Recommendation

The results published in the works of [1] is recommended as guide in the design of new residential structures along the lines of the seismic fault in the South West while seismic retrofitting is recommended for buildings already in existence.

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