Environmental Effects of Road Construction Waste

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Abstract

This research work investigates the various waste streams generated during road construction and their effect on environment. The method employed in this research work is categorized into waste type generated on construction site using reconnaissance surveys, data collection and data analysis methods. Four construction project sites in Minna, Nigeria, were used with the aim that these sites will provide a platform to acquire valuable data. It was discovered that mortar or concrete waste and wood waste has the highest percentage of 22% to 39% and asphalt has about 4 % waste and this was largest percentage of waste generated and this was mainly due to the human error, the use of inadequately trained and unskilled labour. The study however made case for adequate attention and concentration towards improving effective waste management by implementing proper waste management and disposal systems and encouraging the use of recycled materials in road construction. This will greatly reduce the cost of construction, increase efficiency, reduce work time and replenish the earths rapidly depleting natural resources used in construction like wood and bitumen.

Keywords: Waste, Construction waste, Asphalt, Generated waste, unskilled.

1. Introduction

A road is identifiable route, way or path between two or more places. Roads are typically smooth or paved pathways to allow for easy travel along them. Historically many roads were simply recognizable routes without any formal construction or proper maintenance. The first pathways were bush paths made by animals and the humans that hunted them, this dates as far back as 10,000 BC with the iconized way found in Antarctica as the earliest example. In civil engineering terms, a road is a pavement structure consisting of superimposed layers of strong materials over the natural soil for the main purpose of supporting

and adequately distributing wheel loads thus preventing the failure of the sub grade (O'Flaherty, 2001).

A good road network is important for the growth and development of any country. Agriculture, military defense, oil mining and exploration, health care and education are all key sectors of the economy that depend greatly on the accessibility provided by a suitable road network. Owing to the new priority giving to environmental protection in the world; arising from the threat of global warming, desert encroachment, rising water levels and food shortages caused directly or indirectly by the rapid depletion of the earth's Ozone the time has come for a re-think in road construction waste and its effect on our environment (Apotheker, 2021; Bhallerac, 1999; Jones, 1998 and Writar, 2022). Roads must be designed to satisfy multiple needs and their construction must involve suitable techniques aimed at preventing environmental degradation. Environmentally sound road building requires precise knowledge of the potential hazardous effects of improper waste management system and pollution in general (Kadyali and Lal, 2008)

This work is aimed at suggesting waste disposal methods of construction waste materials in and around Minna metropolis. To achieve the aim the following where looked into; (i) identify waste generated by road construction, (ii) provide recommendations on proper waste management systems (iii) recommend a set of guidelines to allow road controlling agencies and environmental protecting authorities to determine if certain waste or industrial by products are suitable for re use in highway construction, (iv) reduce volume of waste landfills, (v) lower cost of construction materials by encouraging recycling and re use an (vi) promote a clean green image for the construction company and in effect the general environment.

2. Methodoly

2.1 Study Area And Method

The method employed in this research work is categorized into determining the type of waste generated on construction site using, Reconnaissance surveys, Data collection and Data Analysis methods. Four construction projects site in Minna, Nigeria, was used. It is aimed that these sites will provide a platform to acquire valuable data, these sites are,

1. The dualisation of government house road
2. The dualisation of Dutsen kura, police headquarters road
3. The dualisation of AP/Keteren Gwari road

4. The dualisation of Ambassador J.T Kolo road

2.2 Reconnaissance survey

A proper survey of the study area (Minna metropolis) and the four road projects mentioned above were selected as case studies, this survey provided valuable information, with the existing situation on the road construction projects. The conditions and nature of work carried out as regards waste generation and disposal methods. The type of materials and techniques used were observed, available plans, maps and photographs of the construction site were studied (Plates 1- 5).

Plate 1: Government House Road

Plate 2: Ambassador J T Kolo road

Plate 3: Government House road

Plate 4: Dutsen kura road concrete waste

Plate 5: Rock Boulders Keteren Gwari roa

2.2 Data collection:

Samples of the various identifiable waste streams from each site were collected, documented and their weights were calculated. Some valuable information both

in oral and graphic forms by asking valuable and relevant questions to this project were collected. Pictures were also taken. Data collection was originally from two sources, (a) primary information obtained through personal observation of road construction sites in and around Minna, the operatives, workers, supervisors involved on each project were directly interviewed orally on issues regarding waste generation, management and disposal and (b) Secondary data which involves extensive review of relevant literature from text books, researches relevant to this project, journals and other papers published in this field. Samples were collected from all the sites and weighed using an electronic weighing machine. The values were recorded and calculated thus:

$$\text{Sample weight} = \frac{mass\ of\ waste}{Total\ mass}\ x100\% \quad (1)$$

2.3 Data analysis:

The collection and analysis of data using the electronic weighing machine and computer generated simulations were employed in cases where the exact values could not be accurately gotten due to volume and weight of waste generated. The problem faced and created by the indiscriminate mis-management of general and construction waste, will be illustrated using valuable data, field photographs and histograms.

3. Results and Discussion

3.1 Study Area

Shown in Figure 1 is the layout of the different road used for the research work.

3.2 Result Presentation

In order to ensure successful achievement of set aim and objectives of this work sources of data representation like the bar chat, pie chart and various tables have been employed based on the information available to ascertain the presence of waste in road construction sites, their percentage by mass and reason why the streams of waste differed.

3.3 Waste Generation Per site

3.3.1 Site one (government house road)

Figure 2, shows the breakdown of waste generated on a construction site. The survey analysis shows that masonry waste is about 33% and miscellaneous is 22% by weight while rock-based debris have 3 % to 6 % been the lowest due to little or no excavation work carried out on this site.

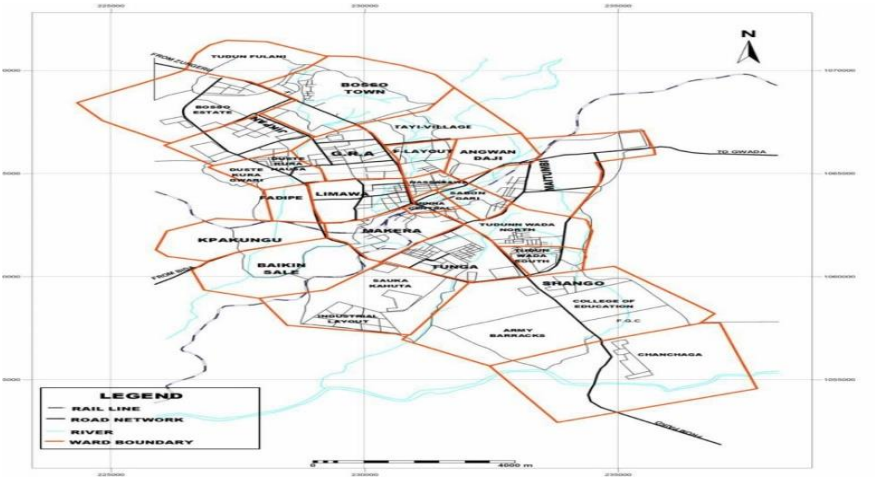
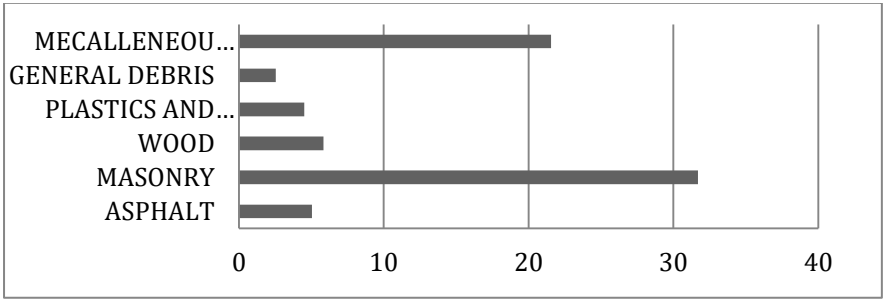


Figure 1: Map of Minna Roads

This imply that Effort should be made by the contract supervisor to curtail the waste of cement and mortal as this will certainly leads to increase in cost of project.



(% Waste by Mass)

Figure 2: Waste Generated from Government House road

3.3.2 Site two (Dutsen Kura Police Headquarters road)

The survey conducted on this site showed that wood has the highest percentage by weight of waste approximately 39.31% generated. This was due to the extensive use of wood for paneling during the construction of side drains and the

scaffolding for the newly constructed box culvert along the route, mortar waste is 25% due to much drainage activities on the road, iron bars and fillings had the lowest percentage at 2.07% because the possibility for reuse is higher. While plastics and asbestos were the least waste on site due to cost and quantity used. Wood, mortar and asphalt were the most used

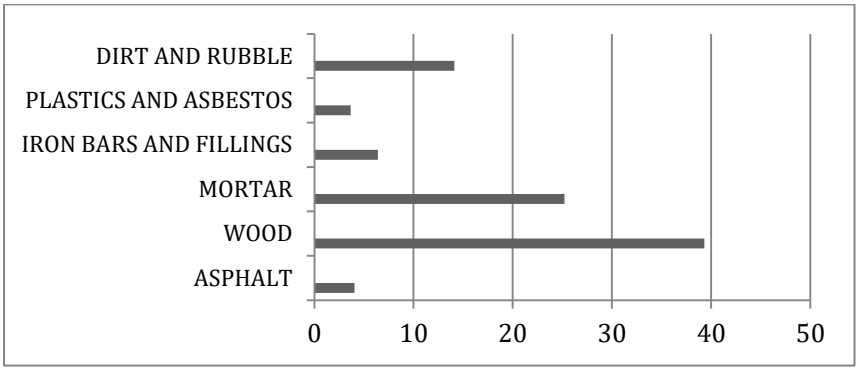
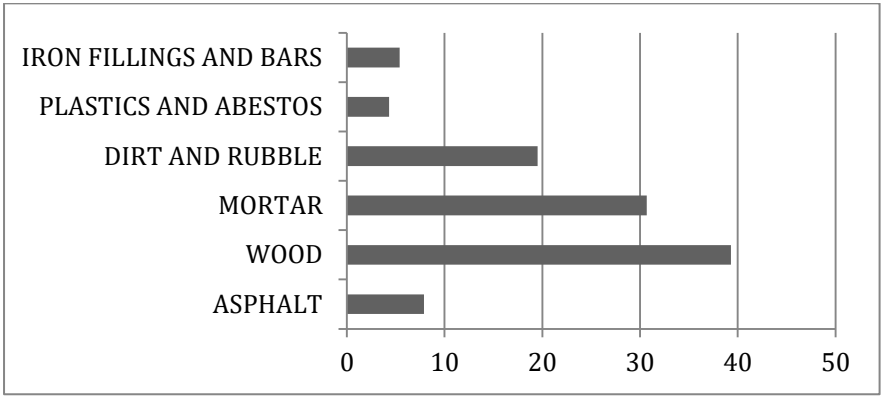


Figure 3: Waste generated from site two Dutsen kura police headquarters road

There was more efficiency in the use of materials on this site. This can be seen from the smaller quantity of waste generated. All of this data can be seen in Figure 3.

3.3.3 Site 3 (Ambassador J.T. Kolo Road)

Figure 4 shows 39 % for spilled mortar/ concrete boulders, dirt and rubble make up 19 % of the total percentage weight of waste generated and iron fillings and plastics has the smallest weight of 6 % and 4 % this again is due to the recyclable nature of iron in road construction. It was discovered that mortar has the highest waste value due to wastages during the construction of culverts, side drains and rings.

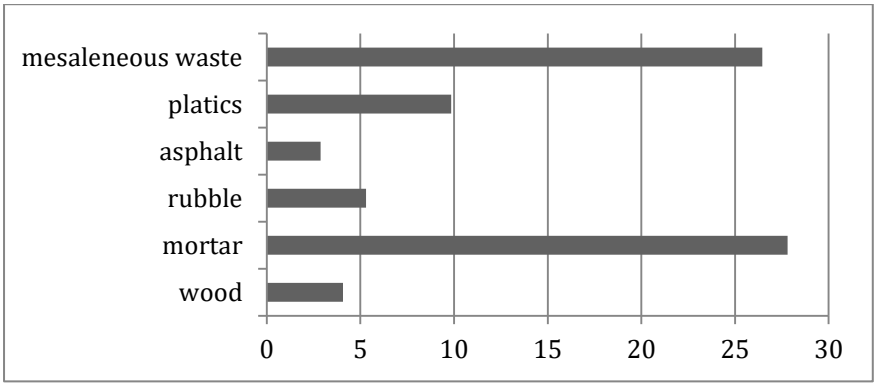


(% Waste by Mass)

Figure 4: Waste generated from site three Ambassador J.T. Kolo Road

3.2.4 Site four (AP Keteren Gwari road)

A noticeable change is seen in the composition and volume of weight generated on site four project, the percentage weight of rubble is 5.31% increases while that for asphalt shows an exponential reduction in percentage by weight to 2.87%. This can be attributed to the fact that material management on this site is high see Figure 5.



% Waste by Mass)

Figure 5: Waste generated from site four (AP Keteren Gwari road)

The above procedure in totality is called the waste index determination and it's used to find out the amount of waste generated, its various streams or composition as regards road construction projects. The waste index for the four sites considered in this research was found not to be significantly different despite the fact that the size, length and area of all four road projects varied. Therefore, waste index for the above mentioned projects were determined to be the overall amount of waste generated as regards type, stream percentage weight and general weight. Material wastes on the sites include, mortar, iron fillings, masonry, asphalt, wood and other general miscellaneous waste.

The various figures used shows that wood, asphalt, and masonry were among the major streams of waste generated among all the four construction projects individually. This analysis was based on data collected on sites through careful observation of used construction procedures, questions asked on site and data samples of waste material collected. The factors that contribute to this amount of waste materials arises from excessive ordering and cutting errors due to unplanned design changes on site (Rounce, 1998) which pointed out that the major highway construction waste sources are at the design stag, the variability in the level of design details i.e. design conditions are not necessarily real life conditions and allowance must be made to accommodate these variations on site. If standardized design layouts are used and allowance for variations are made. Proper translation of these designs is followed the level of waste generated will reduce significantly.
The contribution of human error, poor training and education among hired labour, construction worker and management staff, involving the full participation of everyone involved can help curb these effects. An improvement in storage facilities on site can greatly prevent wastages as most materials and machinery used were stored on site at the full mercy of the elements. Over mixing of cement by ignorant labourers, improper handling of materials, work tools and heavy machinery can cause waste. With proper enlightenment of all parties involved and proper storage systems waste management can be reduced to 0 % (Poon, 2001).

Finally data collected revealed that human error was the primary reason for this level of waste generation and this can be greatly mitigated by the use of prefabricated materials based on real design specifications, reducing the amount of waste by ensuring that the efficient use of materials and the public relations value of a clean site where waste is managed in an environmentally friendly way to boot the green image of the contractor, the reuse of most materials discarded

on site by modifications or created new uses and thus results in efficiently reducing construction cost, lowering disposal cost and in effect reduce the amount of land used for sanitary landfills.

4. Conclusion and Recommendation

4.1 Conclusion

This study examined the environmental effects of poor and inadequate waste management in highway construction with four (4) construction site in the Minna township area used as case study. It was discovered that mortar or concrete waste and wood has the highest percentage of waste (22% to 39%) and asphalt has about 4 % waste and this was largest percentage of waste generated and this was mainly due to the human error, the use of inadequately trained and unskilled labour.

The study however made case for adequate attention and concentration towards improving effective waste management by implementing proper waste management and disposal systems and encouraging the use of recycled materials in road construction. This will greatly reduce the cost of construction, increase efficiency, reduce work time and replenish the earths rapidly depleting natural resources used in construction like wood and bitumen.

4.2 Recommendations

Based on the results and findings of this research project it has become imperative and important to put up some recommendations to improve the management of waste in general and specifically for highway construction projects in order to prevent the environmental and health hazards mentioned earlier and in some cases conserve the earths rapidly depleting resources by encouraging the reuse recycling and investing the possibilities of using alternative materials used in construction in general. The following recommendations are made for effective waste control management in highway construction demolition and renovation.

Encourage Waste Reduction and Recycling; efforts should be made by the government and agencies in charge of waste management so sensitize the general public on the advantages of recycling and reuse of existing waste materials. Road projects that rely on recycled and reused materials should be

encouraged by the government by tax reductions and subsidizing these construction materials

Evaluate Site Layout; this entails adopting improved storage facilities on road construction sites. i.e during the design stage of the project consideration should be given to the site layout for the provision of adequate dump site which will not obstruct the flow of the project and as well provide room for adequate sort in of the various waste streams for transportation to landfill areas, reuse and recycling which efficiency can be greatly increased if the materials are first sorted on site.

Reorganization of Waste Management Agencies: this agency should be reorganized, revitalized and held responsible for waste related issues in the country. Part of their responsibility must include the creation supervision and maintenance of dumpsite and landfills for various types of waste. Categorized based on bio degradability of the waste materials stored there. This allows for proper future recycling and reuse of these materials

Inadequate Information System; highway construction sites need to develop and implement facilities that will maintain the financial data that managers will require to effectively track the rising costs of construction with a view ass's management efficiency which in effect will provide the availability of more found which can be invested into waste control management and disposal. This can greatly reduce the prevalence on indiscriminate dumping of road construction waste along the route as is the practice on most construction sites today.

Involvement and Active Participation by Private Waste Collectors**;** waste management should not be left entirely to the government especially in the area of privatizations and recommendations. Experts in waste management should be employed to provide valuables insight into proper modernized waste management systems. In developed countries waste management and disposal is a very viable sector of the economy. Government should provide incentives for private Nigerian investors who want to participate actively in that sector of the economy, incentives like reduced taxes, provisions of land for landfills and provisions of equipment for recycling plants at subsidized rates. This will provide job opportunities for young unemployed Nigerians because as long as there is waste their jobs will be secure.

Public Enlistment; the need to educate the general public can't be over emphasized on the evils of living with waste and its effect on their health and environment, environmental climatic and aesthetic problems associated with it. a call for environmental awareness through educational campaigns inform of media. The need for environmental control policies, standards for abating pollution and severe punishments should be enforced on all defaulters is it the community or the construction companies in charge of these highway projects

where waste is generated. Such standards imply that the community is community is willing to bear the cost or maintain the codes in order to maintain its environment at a given set quality standard that will not be compromised.

Adequate Subventions: lack off founds and finances is a major problem which has crippled the activities of the waste management agency. Government should Endeavour to provide adequate subventions and or allocation to the agency to enable it purchase all the necessary equipment and hire qualified operatives. This will enhance employment levels.

Accountability**;** construction outfits that default ignore or abuse set environmental codes as regards waste management and disposal should be severely punished, in other to deter or discourage others from this same practices, fines and other monies generated through this practice can help government and its agencies to curb the effect road construction waste is having on the environment.

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