EFFECT OF MUNICIPAL SOLID WASTE LEACHATE (MSWL) ON THE COMPRESSIVE STRENGTH OF CONCRETE

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ABSTRACT
This research used laboratory test techniques to evaluate (investigate) the effect of municipal solid waste leachate (MSWL) particularly, on the compressive strength of concrete. The laboratory test was conducted on 72 concrete cubes of 150mm x 150mm x 150mm in size. The water/cement ratio of 0.55 was used with varying water/Leachate ratios of 100:00, 75:25, 50:50 and 00:100 respectively. The cubes were divided in to two and cured in both water and leachate medium for 7 days, 14 days and 28 days accordingly. The findings revealed that the municipal solid waste leachate (MSWL) reduced the compressive strengths of the cubes after 28 days of age by 2.79 % for zero leachate cured in leachate medium.

Keywords:
Municipal Solid Waste, Dumpsites, Leachate, Compressive Strength

INTRODUCTION

In Nigeria, million tons of municipal solid wastes are produced per annum and most of which are often dumped uncontrolled in an opened area and in many places are found very closed to residential and/ or commercial concrete structures and it is not only in the rural areas but even worst in the urban areas due to high rate of solid waste generation. During raining season, as rain falls onto the dumpsite, or there is flood, Leachate is produced. This municipal solid waste leachate (MSWL) eventually comes into contact with the soil, ground water, and nearby structures.

The issue of solid waste generation and disposal has attracted the attention of writers and scholars alike, particularly in recent years. However, the unfortunate condition of most cities regarding solid waste disposal practice has been discussed extensively in the literature by many scholars. To mention but few, [1], [2], [3], among others, are of the view to looking for a lasting solution to the problems of solid waste and it adverse consequences on human health and environment.

[4] Reviewed that urban areas in developing countries are growing at the very speedy rate compared to the cities in developed countries and such rapid increase of population growth has implication on provision of urban infrastructures and municipal waste management is among the basic social services required in municipal communities.

[5] Argued that: the most common technique for municipal waste management in Nigeria is land fill disposal techniques. He further observed that, it is considered as the cheapest and most readily existing means of waste disposal in developing countries. However he reviewed, the disadvantage of this technique is the resulting environmental consequences of the landfills waste disposal to the people residing around the waste dump environs. This is because about 25% of methane gasses are being emitted from landfills procedure, which also pollute the ground water and it is a potential source of water use for domestic services.

Few other studies have relatively explored solid waste management method using different criteria [1], [6].

LOCATION OF DUMPSITES

[7], ascertains that dumping sites are the most common way of disposal of municipal solid wastes in the cities. Generally, they are found on the outskirts of the urban areas, turning into sources of contamination due to the incubation and proliferation of flies, mosquitoes, and rodents. That, in turn are disease transmitters that affect the child population's health, which has its organic defenses in a formative and creative state. He further stated that decomposition of organic compounds by micro organisms is a common phenomenon. Most organic materials, such as food, wood products, or other remnants of plants, decay, and finally return to the environment

in the form of simple compounds, such as carbon dioxide, water, or ammonia. Surprisingly, it was found that most synthetic organic polymers, including the majority of plastics, are extremely resistant to biodegradation. This phenomenon starts to create significant economical and environmental problems when landfills sites overflow with plastics.

METHODOLOGY AND RESULTS

CHARACTERIZATION OF MUNICIPAL SOLID WASTE (MSW)

The Municipal solid waste sample was taken from the waste dumped along Mubi - bye - pass after removal of the top ones to about a 0.5m depth. The MSW was collected and measured using weighing scale.
The sample was then sorted out according to it physical components. The mass of every component was measured and the percentage by mass was calculated as shown in Table 1.

$$Percentage\ by\ mass = \frac{\text{individual mass}}{\text{total mass}} \times 100\%$$

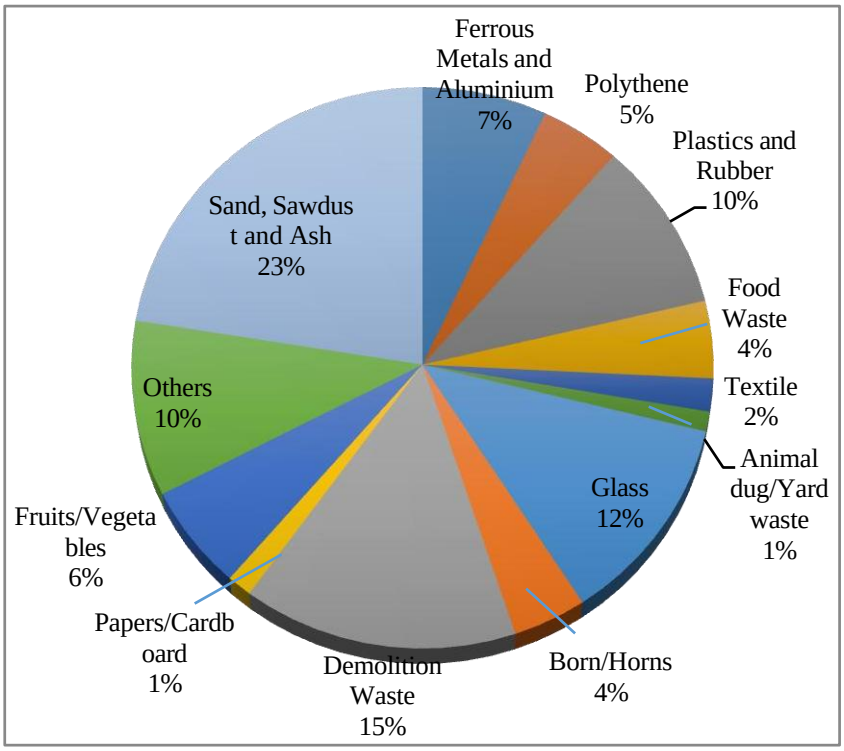

Figure 1: Characterization of the collected MSW (Field Work, 2016)

PRODUCTION OF LEACHATE

A plastic storage tank (1000 litres) was filled with 20 mm gravels up to a depth of 150 mm. The gravels serve as a screen which prevents the blockage of the tap during out flow of Leachate. The MSW was placed on top of the gravels to a depth just more than half of the tank which was later filled with water to it full capacity and was allowed to stay for good seven (7) days. After thorough stirring, the water (Leachate) was collected from the set up into a basin through the tap. The set up is as shown in figure 2 below drawn not to scale.

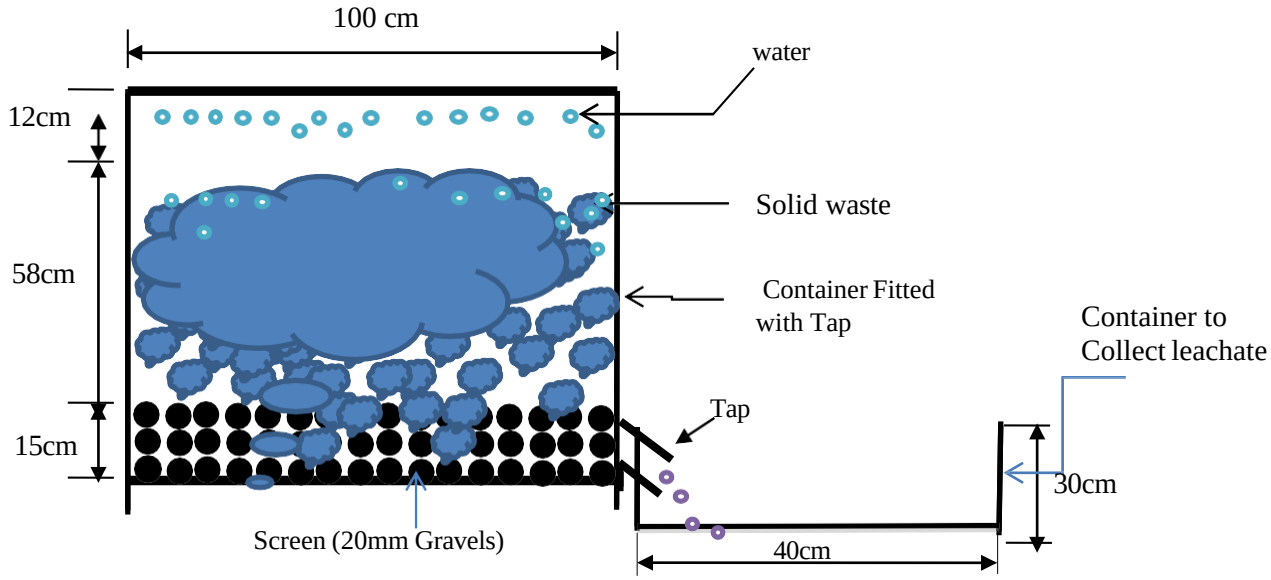

Figure 2: Set-up for Leachate Collection

CHEMICAL ANALYSIS OF THE LEACHATE

The results of the analysis of the MSWL are as presented in Table 1.

Table 1: Chemical Compositions of Municipal Solid Waste Leachate.

Parameters	***Measured Conc. Obtained**	**+Standard Leachate Max. Limits**
BOD_5	240mg/l	2-10mg/l
COD:-	715mg/l	500mg/l
pH	6.73	6.5-8.5
Turbidity	1500NTU	10NTU
TS	865mg/l	500mg/l
TDS	380mg/l	500mg/l
Conductivity	1134mg/l	500-1000mg/l
Pb	0.038mg/l	0.01-0.1mg/l
Fe	6.25mg/l	0.1mg/l
Temperature	28.2^{0C}	28.2^{0C}
Cu	0.139mg/l	0.01-0.1mg/l
Cd	0.005mg/l	0.01-0.1mg/l
Cr	0.036mg/l	0.01-0.1mg/l

***Source: (Field Work, 2016), +After [8]**

COMPRESSIVE STRENGTH TEST (CST)

A total number of 72 cubes of standard size 150mm x 150mm x 150mm were prepared using M15 concrete. The mixed water ratio of 0.55 was adopted for this study. However, the water / leachate ratios of 100:00, 75:25, 50:50 and 00:100 have been used in the preparation of the cubes which were then cured simultaneously in portable water and Leachate medium for a period of 7, 14 and 28 days. The following figures and tables carry the results.

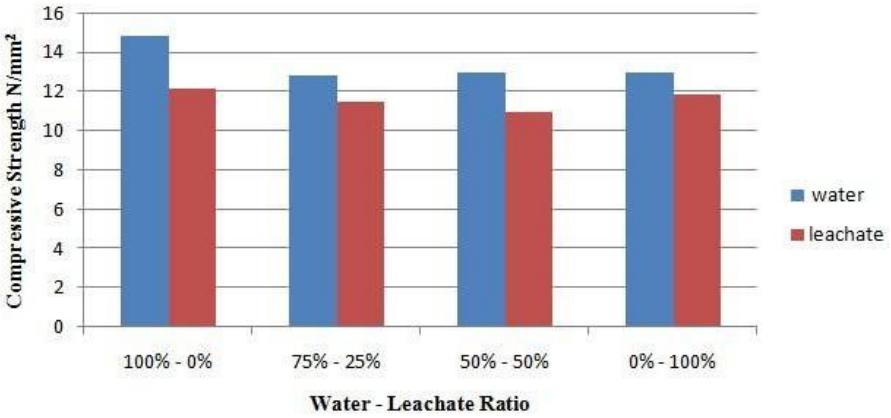

Figure 3: Compressive Strength for 7 days (cured in both water and leachate)

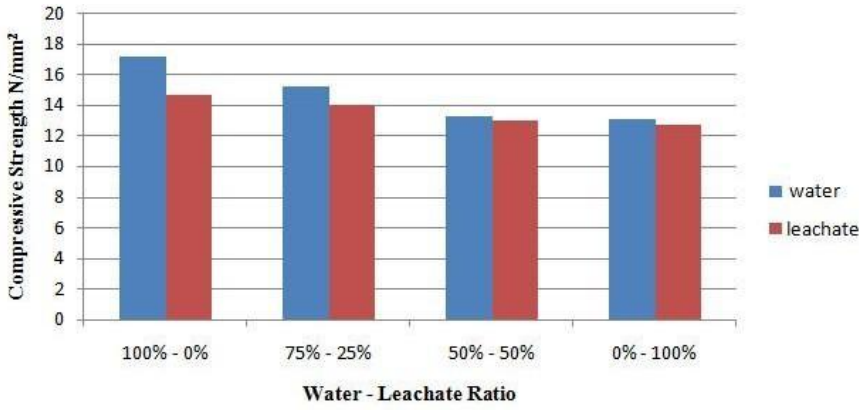

Figure 4: Compressive Strength for 14 days (cured in both water and leachate)

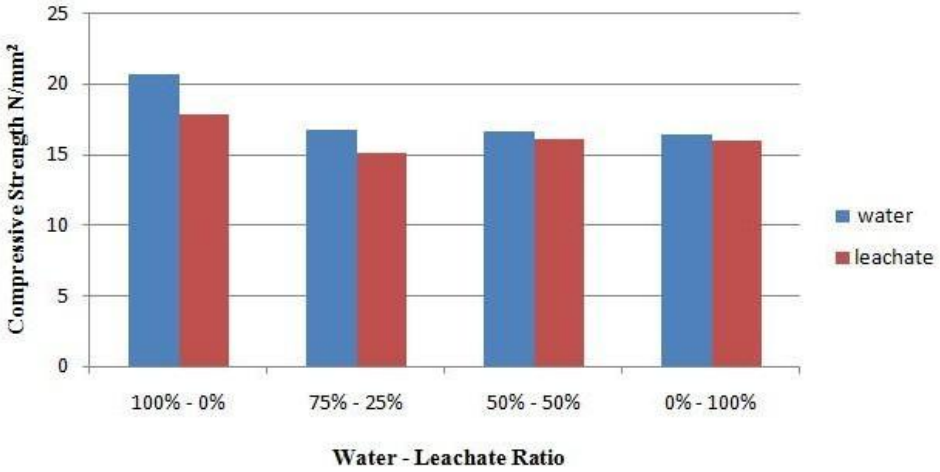

Figure 5: Compressive Strength for 28 days (cured in both water and leachate)

Table 2: Compressive Strength for 7 days (Cured in Water)

Water/Leachate Ratios		Compressive Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
100	0	340	15.11	**14.81**
		325	14.44	
		335	14.88	
75	25	290	12.89	**12.78**
		310	13.78	
		285	12.67	
50	50	305	13.56	**12.92**
		290	12.88	
		280	12.44	
0	100	310	13.77	**12.96**
		295	13.11	
		270	12.00	

Table 3: Compressive Strength for 14 days (Cured in Water)

Water/Leachate Ratios		Compressive Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
100	0	320	16.44	**17.18**
		370	17.77	
		305	17.33	
75	25	315	14.67	**15.22**
		305	16.00	
		330	15.33	
50	50	310	14.00	**13.26**
		290	13.11	
		280	12.66	
0	100	300	13.11	**13.11**
		270	12.89	
		290	13.33	

Table 4: Compressive Strength for 28 days (Cured in Water)

Water/Leachate Ratios		Compressive Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
100	0	460	20.44	**20.66**
		465	20.66	
		470	20.88	
75	25	370	15.11	**16.66**
		380	17.33	
		375	16.66	
50	50	365	16.22	**16.56**
		380	16.89	
		375	16.67	
0	100	340	16.44	**16.37**
		390	16.88	
		375	16.66	

Table 5: Compressive Strength for 7 days (Cured in Leachate)

Water/Leachate Ratios		Compressive Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
100	0	260	11.55	**12.10**
		270	12.00	
		285	12.67	
75	25	275	12.22	**11.48**
		245	10.89	
		255	11.33	
50	50	260	11.56	**10.96**
		245	10.89	
		235	10.44	
0	100	280	12.44	**11.85**
		265	11.78	
		255	11.33	

Table 6: Compressive Strength for 14 days (Cured in Leachate)

Water/Leachate Ratios		Compressive Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
100	0	320	14.22	**14.74**
		370	16.44	
		305	13.55	
75	25	315	14.00	**14.08**
		305	13.56	
		330	14.67	
50	50	310	13.77	**13.03**
		290	12.88	
		280	12.44	
0	100	300	13.33	**12.74**
		270	12.00	
		290	12.89	

Table 7: Compressive Strength for 28 days (Cured in Leachate)

Water/Leachate Ratios		Compressive Load (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
100	0	415	18.44	**17.77**
		375	16.66	
		410	18.22	
75	25	375	16.66	**15.03**
		325	14.44	
		315	14.00	
50	50	350	15.56	**16.07**
		370	16.44	
		365	16.22	
0	100	345	15.33	**15.92**
		370	16.44	
		360	16.00	

CONCLUSION

Based on the laboratory test results, it is obvious that Leachate, even though the concentration is less, has a significant effect on the concrete due to decrease in the compressive strength of the concrete. The degree of decrease in the compressive strength of the concrete was found to be a function of the curing medium and time. Leachate has not only affected the compressive strength of the concrete but also affected the physical appearance of the cubes by turning the cubes brownish in colour with softened mortar like paste on the top.

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