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Comparative Analysis of the Properties of Concrete made from Different Cement Brands in Eldoret Town, Kenya

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Abstract – *Cement is an important ingredient in the production of concrete providing the cementitious and strength development property. In Kenya, there are several cement brands with varying degrees of presence and utilization rates. This research started with a market survey to establish the available brands and their consumption rates in Eldoret Town as a case study. Focus was limited to the cement class 32.5 because they are general purpose cements. Six brands of cement were established to be readily available in Eldoret Town at the time of the study. These were: Nguvu Cement, Tembo cement, Rai Cement, Ndovu Cement, Simba Cement and Nyumba Cement. The others that are normally in the market but unavailable in the study area at the time of market survey include: Blue Triangle Cement, Rhino Cement and Savannah Cement. The six brands were subjected to two tests, Slump test for fresh concrete and Compressive strength test for hardened concrete. The mean 28th day compressive strengths were obtained as follows: Tembo Cement 20.76N/mm^2, Ndovu Cement 23.53N/mm^2, Simba Cement 24.67N/mm^2, Nguvu Cement 27.58N/mm^2, Nyumba Cement 26.27N/mm^2 and Rai Cement 24.02N/mm^2. Statistical analysis of the compressive strengths was carried out for each of the six brands and a comparison across the brands was presented. It was concluded that there was significant difference in the results of Tembo, Nguvu and Nyumba amongst themselves and other brands whereas for Simba, Ndovu and Rai had no significant difference between their results.*

Key Words: **Cement brands, Concrete, Slump, Compressive Strength, Significance test**

1. INTRODUCTION

Concrete properties are influenced by the properties of its ingredients and the processes from mix design, batching, mixing, placing, curing and the conditions under which the processes are undertaken. The quality of cement influences mainly the strength and durability of the concrete. Evidently, there are some marked disparities in the cement quality ranging from production process to other properties attributable to the natural composition of the raw materials. These variations significantly influences the properties of concrete made from the different cements **(Olonade, 2015, [1]).**

Commonly there are specifications for the Portland Cements, based on standards and codes in any country for the targeted physical and chemical parameters of cement being manufactured. In cases where there exists many different brands of cement and where new brands keep emerging into the market, comparative tests become useful in informing the consideration of the brands for given applications.

1.1 Objectives

The objectives of this study were as follows:

- To carry out a market survey on available cement brands and their consumption rates in Eldoret Town, Kenya
- To conduct characterization tests on concrete ingredients
- To carry out tests on the concrete in the fresh state – slump test; and on the hardened state – compression strength test.
- To perform comparative analysis of results of the concrete produced from the different brands of cement.

2. LITERATURE REVIEW

Kolver K. and Roussel N, 2011, [2], described the properties of fresh concrete with interest in the following:

- Workability and rheological properties
- Time effect: Thixotropy, that is, structuration of concrete at rest and de-structuration upon initiation of flow during mixing and placing in the formwork, Slump loss, Setting time and Hydration
- Stability of fresh concrete: bleeding and segregation

They also described hardened concrete properties as primarily compressive strength and durability while other secondary properties include: tensile strength, shrinkage, creep, crack resistance and thermal properties.

Anejo J. A., Lapinni H. G. and Ahmadu A., 2014, [3], conducted a comparative study of selected cement brands in Nigeria at the time and related five different brands in terms of their fineness, consistency, soundness and compressive strengths. In their observation all the brands achieved the standards for the class 32.5 cement.

Win M. T., Aung T. T. and Aung H. S., November 2019, [4], performed a comparison between physical properties of three selected brands of cements in Myitkyina City. They focused on specific gravity, fineness, soundness, setting

times and compressive strengths. Their observation was that while all brands attained values within possible limits, one brand was superior to others in all parameters tested.

Bamigboye G. O. et al., 2015, [5], carried out an assessment of compressive strength of concrete produced from five different cement brands in Nigeria at the time of the study. They investigated the concrete ingredients and tested concretes in terms of setting times and compressive strengths for two different mix ratios concurrently. Their observation was that while all but one brand of cement attained the minimum cube strength, there was a progressive increase in compressive strength from earliest age curing to latest age curing.

Tarek U. M. et al., 2012, [6], investigated different cements being used in Bangladesh in terms of normal consistency, bleeding, initial and final setting times and compressive strengths. They observed a linear correlation between 28th day compressive strengths and final setting times where the former can be predicted with knowledge of the early strengths from quick laboratory test.

3. MATERIALS AND METHODS

The main ingredients of the concrete and their sources were as follows:

1. Ordinary Portland Cements (OPCs) – Class 32.5N cements obtained from retail outlets in Eldoret town, Kenya.
2. Fine aggregates/sand – the natural river sand sourced from Kanyarkwat, West Pokot, Kenya.
3. Coarse aggregates/ballast – mixed-grade crushed natural stone aggregates, consisting of 12 mm and 20 mm aggregates in 50-50 percent proportions sourced from the Eldoret Quarry, Kenya.

3.1 Cement Market Survey

A market study was conducted to identify cement brands that were available in Eldoret Region and their consumption rates and trends. This was achieved through administering questionnaires to sampled cement retail outlets labeled RT01 to RT24 daily for one week in a given month. The outcome was summarized as shown on **Table 1** for a typical day.

The survey indicated that six cement brands were available in the market and at consumption rates (% Sales) of 33.1% for the most consumed and 6% for least consumed for that particular day. It was appreciated that there were numerous factors influencing the outcome and such were not subject of this study and that the results were also time-specific.

3.2 Particle Size Distribution

Standard sieve analysis test was performed for fine and coarse aggregates. These yielded the curves on **figure 1** for fine aggregates and **figure 2** for coarse aggregates.

The grading curves of the fine aggregates indicate a well graded or continuous grading while that of the coarse aggregates indicated a semi-uniformly grading. These were basically acceptable for the aggregate zoning for the tests.

Table -1: Sampled daily cement sales per brand

OUTLETS /BRANDS	SAMPLE DAILY SALES OF CEMENT					
	Nguvu	Tembo	Nyumba	Simba	Rai	Ndovu
RT01	0	0	0	15	0	0
RT02	50	200	0	500	0	50
RT03	10	0	50	0	10	0
RT04	0	0	50	15	15	20
RT05	100	400	1000	0	0	0
RT06	0	0	20	0	30	0
RT07	50	0	200	0	0	10
RT08	200	100	500	0	150	10
RT09	0	0	20	0	0	10
RT10	100	100	300	300	150	50
RT11	50	0	150	0	0	0
RT12	20	50	0	0	0	100
RT13	500	1000	500	500	500	100
RT14	0	15	0	15	0	0
RT15	15	50	30	0	0	40
RT16	0	10	5	0	0	0
RT17	0	10	10	0	0	20
RT18	0	0	20	0	0	50
RT19	10	15	0	10	0	0
RT20	5	10	15	0	10	20
RT21	0	5	5	0	0	0
RT22	0	5	10	0	0	0
RT23	10	30	20	20	0	50
RT24	15	0	20	0	0	0
TOTALS	**1135**	**2000**	**2925**	**1375**	**865**	**530**
% Sales	12.85	22.7	33.1	15.6	9.8	6

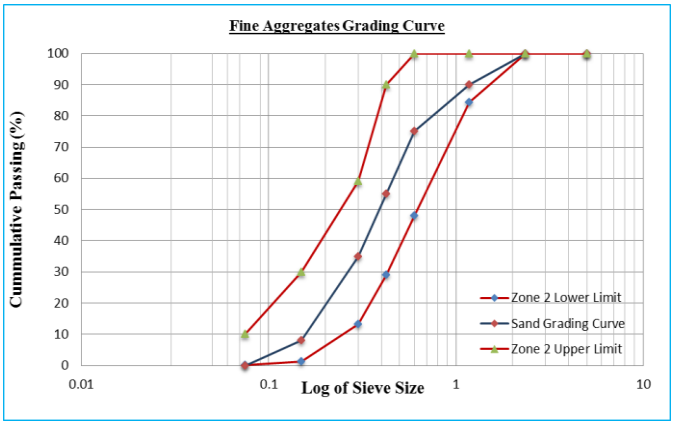

Figure -1: Sieve analysis curve for fine aggregates

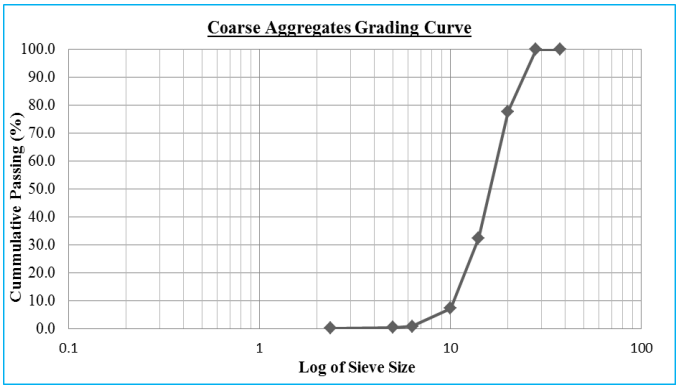

Figure -2: Sieve analysis curve for coarse aggregates

3.3 Tests on fresh and hardened concrete

Concrete was prepared for standard testing of slump for fresh concrete and cubes prepared for testing of hardened state compressive strengths for 7th and 28th day strengths. The results have been summarized in the **table 2**.

Table -2: Results for Slump and Compressive Strength Tests

CEMENT BRAND	SLUMP (mm)	7 - DAY STRENGTH (N/mm^2)	28 - DAY STRENGTH (N/mm^2)
Tembo	100	14.96	20.76
Ndovu	40	16.69	23.53
Simba	120	15.21	24.67
Nguvu	40	17.12	27.58
Nyumba	140	16.29	26.27
Rai	120	15.58	24.02

4. DISCUSSION OF EXPERIMENT RESULTS

It can be deduced from **table 2**, that all the cement brands attained the target mean strength of 20N/mm² for class 20 concrete at 28 days. Nguvu brand achieved the highest compressive strength at 28 days (27.58N/mm²) followed closely by Nyumba brand (26.27N/mm²).

For the workability, it was observed that for most of the cement brands, the concretes achieved good workability, with slump range of 100mm to 140mm. Nyumba brand, with a slump of 140mm, had the highest slump as compared with the rest of the brands. Rai and Simba brands both had a measured slump of 120mm while Tembo brand with a measured slump of 100mm. Nguvu and Ndovu brands both recorded minimal slump results for the prepared mix.

The 7 day and 28 day strengths were used to develop a chart of compressive strength against time as shown in **chart -1**. The chart presented a steady gain in strength for all the cement brands with a much greater growth observed for Nyumba brand and a slight drop in strength gain for Ndovu brand.

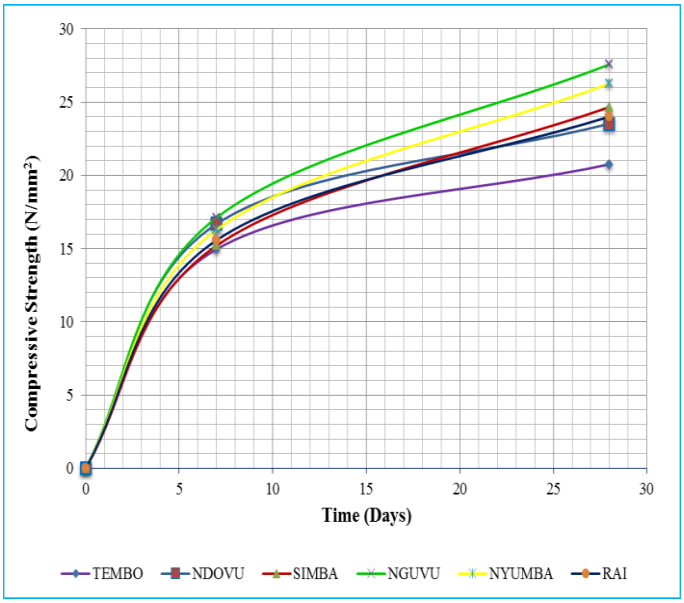

Chart -1: Plot of Compressive Strength of Different Cement Brands against Time

5. COMPARATIVE ANALYSIS

Comparison of the results was done using a simple 2-Tailed T-Test. The procedure was as follows:

i. Two assumptions were made;
   a. Null hypothesis (H_o): Assumed that the means of the populations have no significant statistical difference.
   b. Alternative hypothesis (H_a): Assumed that the means of the populations have a significant statistical difference

ii. Degree of freedom (*df*) of the populations obtained by:

$$df = [(N_1 + N_2) - 2]$$

iii. The *standard error (Se)* and *test statistic (t)* of the populations were computed. These were then compared with the critical t-values (t_{cr}) from the t-distribution tables.

$$Se = \left[\frac{(N_1 - 1){S_1}^2 + (N_2 - 1){S_2}^2}{df}\right]^{\frac{1}{2}} * \left[\frac{(N_1 + N_2)}{N_1 N_2}\right]^{\frac{1}{2}}$$

$$t = \frac{(M_1 - M_2)}{Se}$$

Where;

N_1 and N_2 are the sample population sizes

M_1 and M_2 are the population means

S_1 and S_2 are the standard deviations

iv. The rejection criteria utilized to determine whether the two means are statistically different are:

$t > t_{cr}$ there is significant difference (SD) between the means

$t < t_{cr}$ there is no significant difference (NSD) between the means

The t_{cr} at 5% level of significance is 1.672 for 2-tailed t-test.

v. The test statistic *t* values were obtained and presented on the matrix on **table 3**.

Table -3: T-test values for test statistic *t*

Cement Brands	Tembo	Ndovu	Simba	Nguvu	Nyumba	Rai
Tembo	x	4.01	6.43	10.99	9.87	5.65
Ndovu	4.01	x	1.53	5.32	6.8	0.4
Simba	6.43	1.53	x	4.22	2.52	1
Nguvu	10.99	5.32	4.22	x	2.03	5.37
Nyumba	9.87	6.8	2.52	2.03	x	3.72
Rai	5.65	0.4	1	5.37	3.72	x

x – Signifies an overlap

vi. The matrix of t values on **table 3** were translated using the rejection criteria to come up with the logic significance matrix on **table 4**

Table -4: Logic Significance Matrix

Cement Brands	Tembo	Ndovu	Simba	Nguvu	Nyumba	Rai
Tembo	x	SD	SD	SD	SD	SD
Ndovu	SD	x	NSD	SD	SD	NSD
Simba	SD	NSD	x	SD	SD	NSD
Nguvu	SD	SD	SD	x	SD	SD
Nyumba	SD	SD	SD	SD	x	SD
Rai	SD	NSD	NSD	SD	SD	x

x – Signifies an overlap
SD – means Significant Difference
NSD – means No Significant Difference

6. CONCLUSIONS

The following conclusions can be drawn from the results of the experiments:

i. The Nguvu brand gains highest strengths in both the Day-7 and Day-28 compressive strengths.

ii. The Ndovu brand recorded high compressive strength at an early stage, but the rate of strength gain slowed towards the day-28.

iii. The Nyumba brand gains moderate early strength development and then the rate increased rapidly towards day-28.

iv. The Rai cement brand had moderate strength gain throughout both early and late stages of strength development.

v. The Simba brand had low compressive strength in the early stage, gained strength rapidly by day-28.

vi. Tembo brand recorded the lowest strength gains, across both the early and late stages of strength development.

The following conclusions can be drawn from the comparative analysis:

i. There is no significant difference in the results between Simba, Ndovu and Rai brands of cement

ii. There is significant difference in the results for Tembo, Nguvu and Nyumba between them an all the other brands of cement

REFERENCES

[1] Olanade, K. J. (2015), "Comparative Quality Evaluation of Cement Brands in South West Nigeria", *Volume 9* (1), 53-63, AJSE

[2] Kolver K. and Roussel N, (2011), "Properties of Fresh and Hardened Concrete", Volume 41, pp. 775-792, Cement and Concrete Research, Elsevier

[3] Anejo J. A., Lapinni H. G. and Ahmadu A., (December 2014), "Comparative Study of Physical Properties of Some Selected Cement Brands in Nigeria", Volume 10, Issue 12, pp. 39-44, IJERD

[4] Win M. T., Aung T. T. and Aung H. S., (November 2019), " A Comparison of Physical Properties of Three Different Cement Brands Commonly Used in Myitkyina City", Volume 10, URJSEE

[5] Bamigboye G. O. et al., (2015), "Assessment of Compressive Strength of Concrete Produced from Different Brands of Portland Cement", Vol. 7, No. 8, IISTE

[6] Tarek U. M. et al., (July 2012), "Investigation on Different Cement Brands Commonly Used in Bangladesh", *Third International Conference on Construction in Developing Countries (ICCIDC-III),* Bangkok, Thailand