



AN ANALYSIS OF TIMBER QUALITY AND STRENGTH AS A CONSTRUCTION MATERIAL IN KIRINYAGA COUNTY (KENYA)

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Abstract: A quick search and analysis shows clearly that globally there is an undisputable higher demand of quality construction timber compared to its supply. Kirinyaga County is not an exception to this problem. The use of timber in its green state, use of softwoods and use of timber derived from immature trees has greatly compromised the quality aspect. This compromise on quality and strength constitutes a problem which formed the basis of this study.

The objective of the study was to assess the quality and structural strength of construction timber. Experimental research design was used to achieve the objective. Samples of timber species were collected and tested for various mechanical properties. Visual inspection was carried out to determine various timber defects.

Results show that there is low supply of hardwoods and the timber used contained high moisture content percentages. The tests carried out included compressive strength, static bending, hardness and shear strength which were all negatively affected by the high moisture content percentages. Through visual inspection, it was established that most of the timber had defects. To address this problem, more hardwoods should be planted while at the same time increasing tree cover to 10% as globally recommended.

Keywords: Construction timber, Analysis on strength of timber, Demand versus supply of construction timber, Sustainability.

I. INTRODUCTION

Through studies, it has been established that there has been a gradual and sustained population increase in Kenya which has in effect led to an increase in demand for wood products especially construction timber (Kenya bureau of statistics, 2010). It is a fact that an increase in demand of a resource often leads to competition of the same which in turn causes low supply. A low supply necessitates seeking of alternatives which in turn compromises on the quality aspects. This compromise forms the basis of the problem to be addressed through this study. It is on the basis of this pressure on demand of quality construction timber that this research study intends to explore and provide solutions in an effort to address the problem.

With Kenya not being an exception, the pressure on demand of natural resources in many regions has continued to intensify mainly as a result of population increase (Lusigi, 1994). In Kenya, the demand of sawn wood is projected to rise from 203,000m³ in 1990 to 262,800 m³ in 2020 (Kenya Forestry Master Plan - KFMP). The demand of housing in Nairobi and other major towns has also contributed to shortage of construction timber. To bridge the gap, the country is often forced to turn to Democratic Republic of Congo and other neighboring countries for timber supplies but often at prohibitive costs as high as double digits especially due to transport costs. Through this study, aspects of demand and supply were analyzed and the results do confirm that the demand of quality construction timber has actually far much outstripped supply. The objective of this study is therefore to assess the structural quality of construction timber in Kirinyaga County.

II. METHODOLOGY

An experimental design was used in the analysis of the quality and strength of construction timber used in Kirinyaga County. The sampled species were tested using a universal testing machine (Model no USTM-Identity: T42B4/A/32120: Capacity-500KN) the tests carried out included compressive strength, static bending, shear strength and hardness. Sample sizes of clear specimens without defects were of 20x20x20mm for testing shear strength, 20x20x60mm for testing compressive strength and 20x20x100mm for testing hardness, and 20x20x300 for testing static bending. Moisture content percentage was also determined. Timber defects (imperfections) were determined through visual inspection.

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The test samples comprised both the hardwoods and softwoods. The sampling unit was Kirinyaga County which was zoned into four blocks (constituencies) namely; Kirinyaga East, Kirinyaga West, Kirinyaga Central and Kirinyaga South. To narrow down further, in each of the four constituencies, specific locations/ towns were sampled.

III. RESULTS AND DISCUSSION

From the study, it has been established that there is a glaring lack of most hardwood species and certain specific timber sections in the market in Kirinyaga County. Out of the samples tested, 60% were softwoods while hardwoods accounted for 40%. The government ban on logging in the year 2000 meant that only small quantities of trees could be released from government forests after attaining maturity/harvesting age. Ordinarily, hardwoods take years to mature compared to softwoods which take a shorter time. The dwindling fortunes from the traditional cash crops such as tea and coffee has also encouraged farmers to prefer planting trees that take a shorter time to harvest so as to remain afloat economically. These statistics show how the demand of quality construction timber is higher than supply.

Through questionnaires, the quality aspect was addressed. For example, the Contractors were asked to state the scientific methods they use in testing construction timber. From the responses, majority of them confirmed only performing rough visual inspection of the timber defects and smelling to determine the wetness. Only one respondent claimed to use government laboratory for testing moisture content %.

For County Forest Officers, the question, “Are there national and international policy guidelines that regulate timber production and usage to ensure quality timber sustainability?” was administered. On this, most of the respondents indicated that nationally one was required to obtain a permit to cut trees and a license to operate a timber business.

Consideration of age factor when buying trees for conversion to timber is a question that was administered to saw millers. One respondent said that he uses a rough check by way of observing seeds and flowers while the others did not consider the age factor because of the shortage.

Through laboratory testing, some sampled species were found to contain moisture content values of more than 100% (Table 1). The high levels of moisture content shows that most of the timber is used in its green state as a result of low supply. A higher supply would generally allow enough time for seasoning before use. Higher moisture contents also affect negatively most of other mechanical properties of timber such as compressive strength.

To determine the strength characteristics, various tests were carried out. These tests included compressive strength, static hardness, shearing strength and ultimate strength in static bending.

The **compressive strength** of any particular timber is higher when tested dry than when tested in its green state. A low compressive strength causes shortening or buckling of either a column or a strut when loaded. The results derived from this study shows that more than 68% of the tested samples had a moisture content of more than 20%. The high levels of moisture content % shows how the structural quality of construction timber is compromised in this County.

Table 1 shows the mean compressive strengths and moisture contents derived from the study. To arrive at the mean, results of the six tested samples were used to carry out the calculation.

Table 1
Mean compressive strengths in N/mm² and mean moisture contents (%)

S/no	Specimen code	Mean compressive strength in N/mm ² (mpa)	Mean moisture content (%)
1	Euc	35.06	54.0 ±9.9
2	Cord 1	34.86	16.9 ±0.85
3	Cyp	33.94	18.6 ±0.85
4	Gre	32.68	49.8 ±11.5
5	ES	50.05	56.4 ±3.2
6	PS	17.61	16.0 ±0.65
7	DN	23.55	18.6 ±0.65
8	DK	31.03	98.4 ±43.8
9	GN	20.71	104.3 ±17.6
10	NE	28.88	82.5 ±17.7
11	CS	21.60	54.4 ±11.3
12	DS	23.86	15.0 ±1.3
13	GS	25.57	100.4 ±12.1
14	GK	23.29	54.6 ±3.4
15	EK	45.75	26.8 ±2.7
16	CN	31.57	57.7 ±8.4

Static hardness is one of those mechanical properties that was affected negatively by moisture content of timber (Table 2). For example, at a moisture content of 27.8%, a load of 3.38 N/mm² (on tangential side) was required to cause indentation to *eucalyptus saligna* (a species sourced from Kirinyaga East Constituency) while a load of 7.2N/mm² was required to cause a similar indentation at a moisture content of 12% as reported in a study by Chikamai et al (2001). These results clearly show that more load is required to cause indentation when the timber is tested dry, that is, when it is tested at recommended 12% moisture content.

Table 2: Mean loads to cause indentation for the tested species with various initial moisture contents

S/no	Specimen code	Mean load on tangential(N/mm ²)	Mean load on radial(N/mm ²)	Mean moisture content %
1	EUC	3.8	3.3	57.8
2	GRE	3.0	2.8	49.1
3	CYP	2.0	2.0	18.6
4	CORD	2.6	2.6	18.0
5	GK	2.9	2.8	59.9
6	GN	2.4	2.2	109.7
7	PS	1.66	1.7	18.0
8	GS	2.9	2.9	97.0
9	NE	2.3	2.5	91.7
10	CS	2.0	1.9	64.1
11	EK	3.4	3.2	27.8
12	DK	2.6	3.0	115.2
13	DN	0.9	1.1	21.0
14	ES	3.8	3.6	47.4
15	DS	1.9	1.7	17.2
16	CN	2.3	2.1	45.7

Static bending is a test which is of primary importance in timbers subjected to traverse bending and in most dry softwoods it is typically in the region of 70 N/mm². As it is evident from the results as shown in Table 3, 68.8% of all the tested species had a modulus of rupture (MOR) less than 70N/mm². This shows that most of the timber used is of low quality.

Table 3: Mean load P₁ (kN), extension E (mm), modulus of elasticity (MOE) and modulus of rupture (MOR)

Specimen code	P ₁ (kN)	E (mm)	MOE (N/mm)	MOR (N/mm ²)
GRE	0.89	3	30413	73.33
EUC	1.03	3.08	35443	76.72
CORD	0.72	3.08	24810	65.01
CYP	0.76	3.5	26125	62.74
CN	0.81	3.33	27897	77.75
DK	0.84	4.08	28698	68.25
GN	0.72	4.17	21248	49.79
CS	0.64	5.08	21781	46.81
EK	1.26	3.25	43047	91.79
NE	0.95	3.08	32414	66.59
DN	0.79	3.83	27040	51.01
PS	0.72	3.9	24833	52.08
ES	1.42	3.25	48820	104.13
GK	0.74	4.08	25268	48.65
DS	0.66	3.9	22467	48.48
GS	0.84	4.3	28812	59.41

Shear strength is a property that was also tested. Clear specimen sizes of 20x20x20mm were used. The shearing of timber tested parallel to the grain (along the radial lines) is low and it is typically in the region of 11 N/mm² for dry softwoods but high when the same timber is tested perpendicular to the grains (along tangential lines), see Table 4. From the results, 83% of all samples tested had a shearing strength (along the radial lines) of below 11 N/mm². This also shows how the technical quality of timber was affected negatively.

Table 4: Shear test results

Specimen code	Mean initial weight	Max load(N/ mm ²)in tangential	Max load (N/ mm ²) in radial	Mean oven dry weight
CN	5.9	12.0	9.6	3.7
DK	7.1	8.8	11.6	3.9
GN	7.5	7.8	6.1	3.9
CS	5.5	9.6	9.0	3.5
EK	6.4	12.5	9.5	5.0
NE	7.1	9.3	8.8	4.0
DN	3.5	7.2	7.6	2.9
PS	4.1	9.4	9.6	7.0

ES	8.1	10.7	11.7	5.5
GK	6.5	8.8	9.7	4.4
DS	3.5	8.3	8.4	3.1
GS	8.1	9.3	10.4	4.3

Almost all mechanical strength properties of timber are normally affected negatively by defects occurring in timber regardless of whether they are natural, or resulting out of conversion or seasoning. Various timber defects were analyzed for each constituency. Table 5 shows results of timber defects as inspected in Kirinyaga Central Constituency.

Table 5: Timber defects of tree species in Kirinyaga Central Constituency

	Eucalyptus	Grevillea	Cypress	Cordia africana	Jacaranda
Bow	66.7	50	33.4	66.7	33.4
Spring	16.7	16.7	0	16.7	0
Twist	16.7	16.7	0	16.7	0
Cup	33.4	16.7	0	0	0
Wane	0	0	0	0	0
Knots	16.7	33.4	16.7	16.7	16.7
Fissure	0	0	0	0	0
Decay	0	0	0	0	0
Borer holes	0	0	16.7	0	0
Splits	16.7	16.7	0	16.7	16.7
Bark and resin pockets	16.7	16.7	16.7	33.4	0

IV. SUMMARY AND CONCLUSIONS

This study was undertaken to make an analysis of quality and structural strength of timber as a construction material Kirinyaga County. From the results of the study, it was established that the demand of quality construction timber (especially hardwoods), is higher than supply and therefore constitutes a problem that needs to be addressed. Through the use of feedback from questionnaires, observation and laboratory tests, results do show that in the market, there is a glaring general lack of well-seasoned construction timber, particularly in the category of hardwoods and larger timber sections such as 200mmx50mm from across the board. From laboratory tests, all the tested samples had a moisture content of more than 12% and 0.06% of some species registered a moisture content of more than 100%. A higher moisture content % affects negatively almost all mechanical properties. Again, from the responses arising from questionnaires, it was evident that rarely do Contractors and other timber users use scientific methods in testing construction timber for moisture content and other mechanical properties. The harvesting of immature trees as a result of shortage is a common phenomenon in this County often leading to use of inferior timber. The use of defective timber was also witnessed through sampling of timber in timber yards and construction sites. The use of low structural quality timber is a problem resulting from government ban on logging, an ever increasing population, increased demand of timber as a result of a growing economy, massive deforestation, poor governance policies among other factors. The magnitude of the problem is big and requires urgent government intervention. Achieving the globally recommended 10% tree cover through the vision 2030 initiative would be critical.

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