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Experimental analysis of warping torsion and bending in timber box beams

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Abstract

In order to solve the problem in the analysis and design of timber box beams, this work applied the principle of minimum potential energy theorem in fabricating and testing timber box beams. This was achieved by applying an experimental approach in minimization of the potential energy of timber (an anisotropic material) which has variations in its intrinsic materials properties. A procedural testing of natural warping, and bending was done by carrying out investigation of pure bending of box beams using a compressive strength testing machine of maximum designed strength of 2500kN and carrying out investigation of pure bending of box beams using a flexural testing machine of maximum designed strength of 100kN. Consequently, a fabrication of box beams was done.. A comparative analysis was done to compare values obtain from the analytical method and the experimental values. It was observed that the test results from different species were in correlation with the analytical method.. The following deductions were made: In the longitudinal warping rates, the range of rate of warping are Danta (0.33 % to 1.67%) , Okan (0.5% to 1.22%), Agba (0.33% to 0.83%) and Afara (0.05% to 0.83%) in their descending order .In the lateral warping rate, the ranges of rate of warping are Okan (0.03 % to 2.33%), Danta (0.11% to1.0%), Agba (0.11% to 1.0%) and Afara (0.06 to 0.11%) in their descending order. In the radial warping rate, the ranges of rate of warping are Danta (0.5% to 1.34%),Agba (0.11% to 1.33%), Okan (0.03% to 1.33%), and Afara (0.06 % to 1,33%) also in their descending order. The racking forces in the flexural box beams tests are Okan(95kN), Danta (74kN), Afara(45kN),and Agba (31kN) in their descending order. The racking forces in the compressive box beams tests are Okan (107kN), Danta (60kN), Agba (50kN), and Afara(12kN) in their descending order. The jagged effect experienced by the box beam towards failure being caused by the progressive splitting of the extreme tension fibres shows that before the ultimate racking force, the box beam has been acting as a monolithic system, thus it resists the maximum force before failure occurs. The renewed increase in strength which tends towards the near maximum, but not the ultimate, occurs due to the resistance offered by the fibrous material of the timber species. This is an indirect method of accessing the resistibility of individual species fibrous material, it can be stated therefore that for the four species tested their fibrous resistibility are given in their descending order Okan, Agba, Danta and Afara. This study has confirmed that distortion of timber equally varies with different species.

Keywords: Beam, bending, box , timber, warping.

1. Introduction

Timber has serous worries by all the users, and warping is one of the worries. Warping can be natural warping (caused by natural conditions) or torsional warping (induced or warping caused by a force). Both cases generate effects when in use. All the effects affect the use as many fabricators could not handle it in solving problems both of short span or long span. This often leads to the conclusion that other materials (steel and concrete) are better. These other materials equally have their worries ranging from shrinkage to splurring. The focus of this study is defined by the problem in the analysis and design of timber box beams. There is need to obtain an optimization technique that can be used. This will be useful and relevant in cost/usage of optimization of timber in construction works and other engineering construction. The problem of research output in the application of connection/fastening techniques, and timber bridges construction as in box bridges, box beams and roof beams can be tackled. The research solves the problem of creating accessibility in river line areas and water logged zones in Nigeria by creating an alternative/cheaper/available bridge design and fabrication mechanism which can serve on a temporal or a permanent basis that is cheaper, affordable and available. Also new understanding of the torsional response of the timber material used in different fabrication of structural members in other areas of applications has to be created. so that long spans beams can equally be fabricated in timber. The aim of this research is to create acceptability of timber as a construction material that is cheap and durable and to carry out an experimental work in verifying how the variation properties of timber species correlate with the elasticity of the timber beams. The main objective of this research work is to provide an alternative mechanism and material that can bring about the following in Nigerian timber species

(i) Cost optimization of timber trusses and beams made in Nigeria timber species.

(ii) Cost optimization of timber bridges as in box bridges in use in most river lines areas.

(iii) To analysis numerically the stresses in cells of timber box beams.

(iv) Using different timber species to construct different shapes and grooves and find out which timber species / shapes are optimal and to find out the durability and the cohesive effects of the connection stresses.

(v) To determine the response of other timber species to such stress.

Timber warping is a "deviation from flatness in timber as a result of stresses and uneven shrinkage. Warping can also occur in wood considered "dry" (wood can take up and release moisture indefinitely), when it takes up moisture unevenly, or - especially - is allowed to return to its "dry" equilibrium state unevenly, too slowly, or too quickly. Many factors can contribute to wood warp; wood species, grain orientation, air flow, sunlight, uneven finishing, temperature - even cutting season and the moon's gravitational pull are taken into account in some traditions (e.g., violin making).Wood warping costs the wood industry in the U.S. millions of dollars per year"(agrilife.org/2003). Straight wood boards that leave a cutting facility sometimes arrive at the store yard warped. This little understood process is finally being looked at in a serious way. Although wood warping has been studied for years, the warping control model for manufacturing composite wood hasn't been updated for about 40 years. A researcher at Texas A&M University (Zhiyong 2003) has studied wood warping, and was working on a computer software program in 2003 to help manufacturers make changes in the manufacturing process so that wood doesn't arrive at its destination warped after it leaves the mill or factory. Many researchers have asked questions on warping of timber beams. Guest and Richardson (2012) observed that over the past several years in their country, large wood beams (4x12 by 15 feet plus long) noticeably warped (torque) 15-25 years after installation, and that it typically occurred during July and August (heat of the summer) and very quickly (a few hours to a day or two). The beams were in houses (garages or roofs) and were protected from the elements. There were no apparent outside forces acting on the woods (except for the design loads that have been there for decades). Could anyone shed light on why this happened (it was the long time span that puzzled them)? Ezeagu (2005, 2008) has examined the utilization of timber in Nigeria. Moreover there is need for development of appropriate technology for advanced testing of structures and materials coupled with the problem of updating the Nigerian design code of practice (NCP2 1973).

2. Materials and Methods

In order to achieve the set aims and objectives. The following methods shall be applied;

a In measuring lateral warping, warping is expressed in bending of the grading by width. It is observed in boards of tangential sawing

b. In longitudinal warping, it is expressed in bending of the grading by length on the plane of face or edge as:

$$\text{Rate of warping} = \frac{\text{Max. def. along the length}}{\text{Total length}} \%$$

c. In spiral warping, it presents itself as a winding curvature of the grading by length:

$$\text{Rate of warping} = \frac{\text{deviation from linear plane}}{\text{Max width}}$$

d. Fabrication of various box beams grooves with different species, difference web and flange thicknesses of 25mm and 50mm. The standard sizes of boxes fabricated are (200mm x 200mm x 300mm) and (200mm x 300mm x 900mm).

e. Investigation of pure bending and generalised torsion of box beams using a compressive strength testing machine of maximum designed strength of 2500kN.

f. Investigation of pure bending and generalised torsion of box beams using a flexural testing machine of maximum designed strength of 100kN.

These tests are done in accordance with BS EN 380 1993. The general principle involves applying a stated regime of loading to a timber structure, over a stated period of time and observing the corresponding deformations and reporting the test results. It recommends basic loading procedure of (0-7) steps as described in the table 1.

Table 1. Basic loading procedure in accordance with BS EN 380: 1993

Procedural step	Loading procedure	Time in seconds
0	Only G_1 acting (initial load acting)	
0-1	Apply $F = G_2$ (initial load + first increment)	
1-2	Maintain $F = G_2$	
2-3	Apply $F = G_2 + 0.5Q$(additional gauge load)	
3-4	Remove 0.5Q	
4-5	Apply $F = G_2 + Q$	
5-6	Maintain $F = G_2 + Q$	
6-7	Increase F until $nF_{max,est}$ is reached	

The maximum loading rate shall not exceed 0.25Q per 60s.

3. Results

Rate of Warping .The tables show the observed lateral, longitudinal, and spiral warping;

1. Longitudinal warping:

Table 2. Longitudinal warping for species type: Agba (Gosswellerodendron balsamiferum),

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	2	300	0.67
2	(25 x 200x 300)	2	300	0.67
3	(25 x 200x 300)	1	300	0.33
4	(25 x 200x 300)	2.5	300	0.83
1	(25 x 200x 900)	5	900	0.56
2	(25 x 200x 900)	3.5	900	0.39
3	(25 x 200x 900)	4	900	0.44
4	(25 x 200x 900)	4	900	0.44

Table 3. longitudinal warping for Specie type: (Afara Terminalia superba.)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	2.5	300	0.83
2	(25 x 200x 300)	2.5	300	0.83
3	(25 x 200x 300)	2.5	300	0.83
4	(25 x 200x 300)	2.5	300	0.83
1	(25 x 200x 900)	3	900	0.33
2	(25 x 200x 900)	0.5	900	0.05
3	(25 x 200x 900)	0.5	900	0.05
4	(25 x 200x 900)	1.0	900	0.11

Table 4. longitudinal warping for Specie type: Okan (Cylicodiscus gabanensis)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	1.5	300	0.5
2	(25 x 200x 300)	1.5	300	0.5
3	(25 x 200x 300)	3.0	300	1.0
4	(25 x 200x 300)	3.0	300	1.0
1	(25 x 200x 900)	5	900	0.5
2	(25 x 200x 900)	15	900	1.67
3	(25 x 200x 900)	6	900	0.67
4	(25 x 200x 900)	11	900	1.22

Table 5. longitudinal warping for Specie type: Danta (Nesogordonia papaverifera)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	1.0	300	0.33
2	(25 x 200x 300)	2.0	300	0.67
3	(25 x 200x 300)	4.0	300	1.33
4	(25 x 200x 300)	5.0	300	1.67
1	(25 x 200x 900)	5	900	0.56
2	(25 x 200x 900)	3	900	0.33
3	(25 x 200x 900)	4.5	900	0.5
4	(25 x 200x 900)	4	900	0.44

2.. Lateral warping:

Table 6. lateral warping for Specie type: Agba (Gosswellerodendron balsamiferum),

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	3	300	1
2	(25 x 200x 300)	1	300	0.33
3	(25 x 200x 300)	2	300	0.67
4	(25 x 200x 300)	1.5	300	0.5
1	(25 x 200x 900)	1	900	0.11
2	(25 x 200x 900)	4	900	0.44
3	(25 x 200x 900)	1	900	0.11
4	(25 x 200x 900)	1.5	900	0.17

Table 7. lateral warping for Specie type: (Afara Terminalia superba.)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	0.25	300	0.083
2	(25 x 200x 300)	0.25	300	0.083
3	(25 x 200x 300)	0.25	300	0.083
4	(25 x 200x 300)	0.25	300	0.083
1	(25 x 200x 900)	1.0	900	0.11
2	(25 x 200x 900)	0.5	900	0.06
3	(25 x 200x 900)	0.5	900	0.06
4	(25 x 200x 900)	0.5	900	0.06

Table 8. lateral warping for Specie type: Okan (Cylicodiscus gabanensis)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	1.5	300	0.5
2	(25 x 200x 300)	1.5	300	0.5
3	(25 x 200x 300)	4.0	300	1.33
4	(25 x 200x 300)	1.0	300	0.33
1	(25 x 200x 900)	0.25	900	0.03
2	(25 x 200x 900)	21	900	2.33
3	(25 x 200x 900)	6	900	0.67
4	(25 x 200x 900)	10	900	1.11

Table 9. lateral warping for Specie type: Danta (Nesogordonia papaverifera)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	2.5	300	0.83
2	(25 x 200x 300)	3.0	300	1.0
3	(25 x 200x 300)	2.0	300	0.67
4	(25 x 200x 300)	2.0	300	0.67
1	(25 x 200x 900)	1	900	0.11
2	(25 x 200x 900)	2.5	900	0.28
3	(25 x 200x 900)	2	900	0.22
4	(25 x 200x 900)	4	900	0.44

3. Radial warping:

Table 10. Radial warping for Specie type: Agba (Gosswellerodendron balsamiferum),

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	1	300	0.33
2	(25 x 200x 300)	1.5	300	0.5
3	(25 x 200x 300)	4	300	1.33
4	(25 x 200x 300)	1	300	0.33
1	(25 x 200x 900)	4.5	900	0.5
2	(25 x 200x 900)	3	900	0.33
3	(25 x 200x 900)	1	900	0.11
4	(25 x 200x 900)	3	900	0.33

Table 11. Radial warping for Specie type: (Afara Terminalia superba.)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	0.25	300	0.083
2	(25 x 200x 300)	0.25	300	0.083
3	(25 x 200x 300)	0.25	300	0.083
4	(25 x 200x 300)	0.25	300	0.083
1	(25 x 200x 900)	1.0	900	0.11
2	(25 x 200x 900)	0.5	900	0.06
3	(25 x 200x 900)	0.5	900	0.06
4	(25 x 200x 900)	1.0	900	0.11

Table 12. Radial warping for Specie type: Okan (Cylicodiscus gabanensis)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	1.5	300	0.5
2	(25 x 200x 300)	3.0	300	1.0
3	(25 x 200x 300)	3.0	300	1.0
4	(25 x 200x 300)	4.0	300	1.33
1	(25 x 200x 900)	3.0	900	0.03
2	(25 x 200x 900)	6.1	900	0.68
3	(25 x 200x 900)	2	900	0.22
4	(25 x 200x 900)	7.0	900	0.78

Table 13. Radial warping for Specie type: Danta (Nesogordonia papaverifera)

Specimen No	Specimen size (mm)	Measured deflection (mm)	Total length(mm)	Rate of Warping %
1	(25 x 200x 300)	1.5	300	0.5
2	(25 x 200x 300)	1.0	300	0.33
3	(25 x 200x 300)	3.0	300	1.0
4	(25 x 200x 300)	4.0	300	1.34
1	(25 x 200x 900)	8	900	0.89
2	(25 x 200x 900)	2.	900	0.22
3	(25 x 200x 900)	1	900	0.11
4	(25 x 200x 900)	4	900	0.44

Flexural tests. Failure load – Time values.

Table 14. Flexural tests for Species types: Afara (Terminalia superba).

	Time (mins)	2	4	6	8	10	12	14	16	18	20
Beam1	Load kN	4	6.5	7.5	7.0	14	23	37	43	44	11
Beam2	Load kN	4.5	6.5	7.5	7.5	16	27	39	43	46	9
Beam3	Load	3.5	8	7.5	8	14.	25	38	43	45	10
	Ave. kN	4	7	7.5	7.5	15	25	38	43	45*	10

Table 15. Flexural tests for Species types: Danta (Nesogordonia papaverifera)

	Time (mins)	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Beam1	Load	4	11	15	21	25	27	36	48	69	70	63	73	65	45	21	30	14
Beam2	Load	4	11	16	22	25	26	34	50	69	70	63	73	65	45	22	29	14
Beam3	Load	4	11	17	23	25	28	35	52	72	72	66	76	65	45	24	31	17
	AvekN	4	11	16	22	25	27	35	50	70	71	64	74	65	45	23	30	15

Table 16. Flexural tests for Species types: Okan (Cylicodiscus gabanensis)

	Time (mins)	2	4	6	8	10	12	14	16	18	20	22
Beam1	Load	1	3	4.5	7	9.5	13	24	50	79	94	0
Beam2	Load	1	3	4.5	6	9.5	13.	26	50	82	97	0
Beam3	Load	1	3	6	8	11	13	24	47	79	94	0
	Ave kN	1	3	5	7	10	13	25	49	80	95	0

Table 17. Flexural tests for Species types: Agba (Gosswellerodendron balsamiferum),

	Time (mins)	2	4	6	8	10	12	14	16	18	20	22	24	26	28
Beam1	Load	5	7.5	18	27	29	31	30	25	17	21	19	18	12	8
Beam2	Load	5	7.5	18	29	32	31	30	25	19	23	22	19	15	11
Beam3	Load	5	7.5	18	27	29	31	30	25	18	22	19	17	12	8
	Ave kN	5	7.5	18	28	30	31	30	25	18	22	20	18	13	9

Compressive tests. Failure load – Time values.

Table 18. Compressive tests for Species types: Agba (Gosswellerodendron balsamiferum),

	Time (mins)	2	4	6	8	10	12
Box1	Load	20	38	50	45	35	33
Box2	Load	20	44	45	45	37	33
Box3	Load	20	40	55	45	33	33
	Ave kN	20	40	50	45	35	33

Table 19. Compressive tests for Species types: Okan (Cylicodiscus gabanensis)

	Time (mins)	2	4	6	8	10	12	14	16	18	20	22	24	26	28
Box1	Load	15	45	80	98	108	105	90	77	89	104	99	100	75	63
Box2	Load	15	45	80	101	106	106	90	74	89	104	100	100	76	59
Box3	Load	15	45	80	102	107	104	90	74	92	107	101	100	74	58
	Ave kN	15	45	80	100	107	105	90	75	90	105	100	100	75	60

Table 20. Compressive tests for Species types: Danta (Nesogordonia papaverifera)

	Time (mins)	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
Box1	Load	5	15	35	53	55	55	60	55	40	30	33	35	35	37	40	40
Box2	Load	5	15	35	53	55	55	60	55	40	30	33	35	35	37	40	40
Box3	Load	5	15	35	53	55	55	60	55	40	30	33	35	35	37	40	40
	Ave kN	5	15	35	53	55	55	60	55	40	30	33	35	35	37	40	40

Table 21. Compressive tests for Species types: Afara (Terminalia superba).

	Time (mins)	2	4	6	8	10	12
Box1	Load	2	10	13	5	9	5
Box2	Load	2	9	10	4	9	5
Box3	Load	2	11	13	6	12	5
	Ave kN	2	10	12	5	10	5

Table 22. Summary of strength of timber boxes

S/NO	Species type	Botanical name	$t_f = t_w$ =25mm	$t_f = t_w$ =50mm
1	Afara	Terminalia superba	12kN	45kN
2	Agba	Gosswellerodendron balsamiferum	50kN	71 kN
3	Danta	Nesogordonia papaverifera	60kN	74 kN
4	Okan	Cylicodiscus gabanensis	107kN	95kN

Graphical analysis:

The rate of warping of the four specimen of four species (Agba,Afara,Okan,and Danta) tested are graphically analysed below.

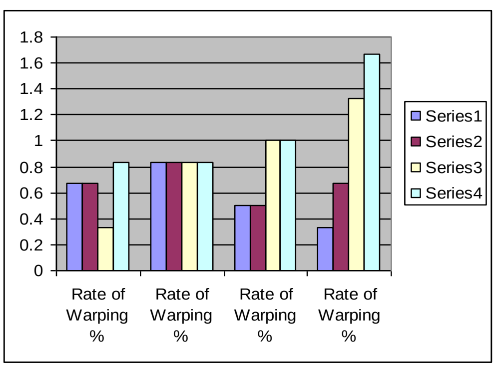


Fig 1: Shows the rate of longitudinal warping for Agba,Afara,Okan and Danta species at 300mm

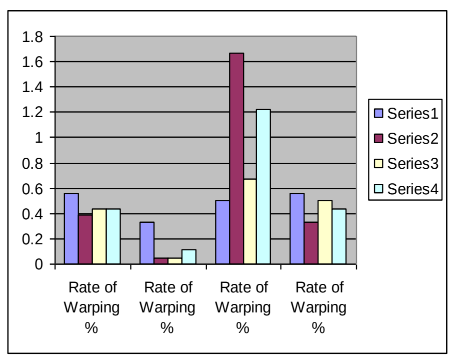


Fig 2: Shows the rate of longitudinal warping for of species Agba,Afara,Okan and Danta at 900mm

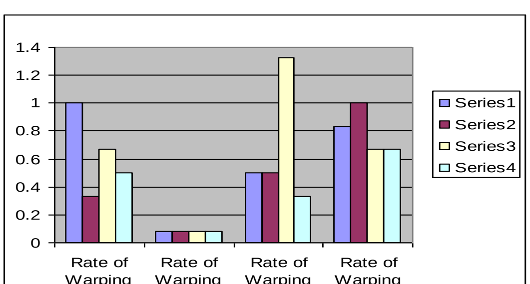


Fig 3: Shows the rate of lateral warping at 300mm

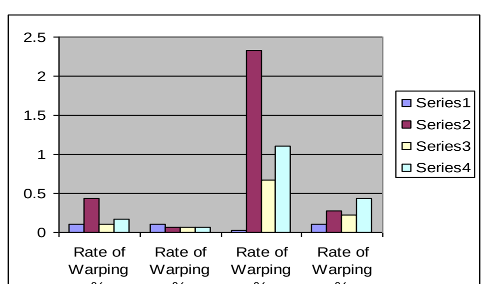


Fig 4: Shows the rate of lateral warping at 900mm

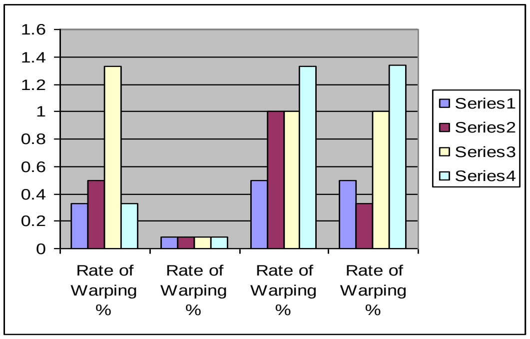


Fig 5 Shows the rate of radial warping at 300m

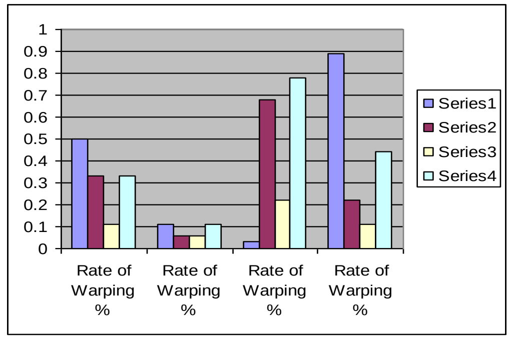


Fig .6: Shows the rate of radial warping at 900mm

The load - time graph

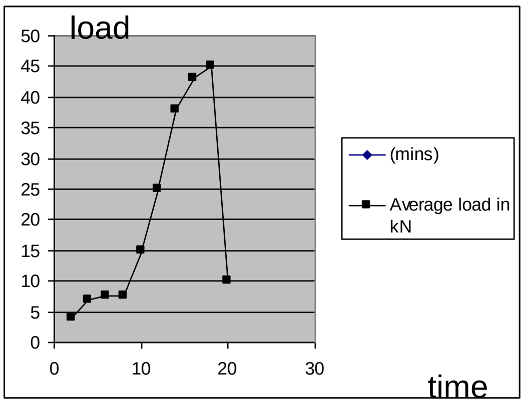


Fig 7: Flexural load – Time graph of box beam for Afara species.

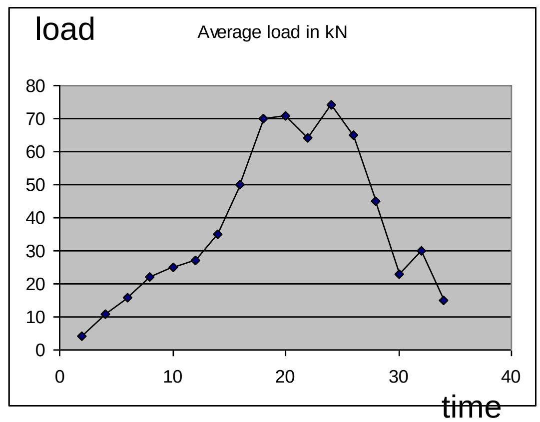


Fig 8: Flexural load – Time graph of box beam for Danta species

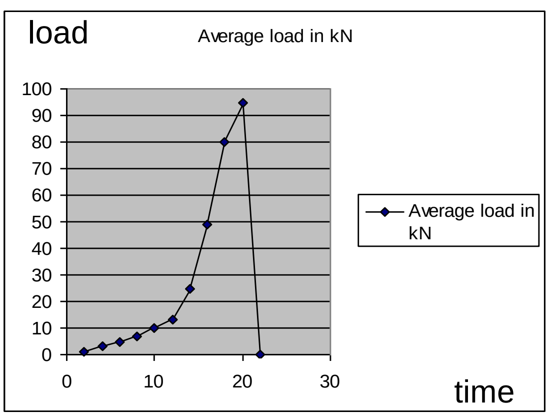


Fig 9: Flexural load – Time graph of box beam for Okan species

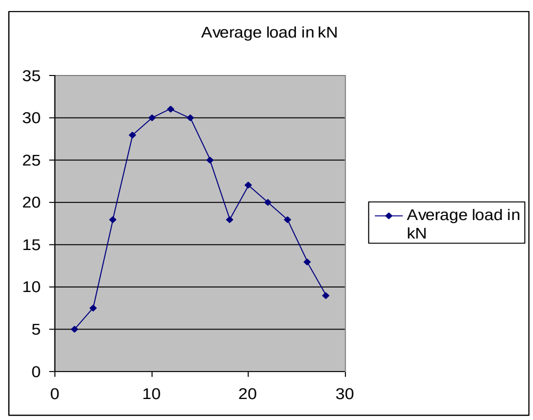
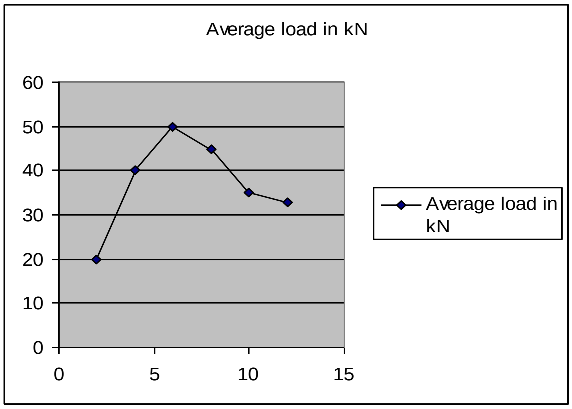


Fig 10: Flexural load – Time graph of box beam for Agba species



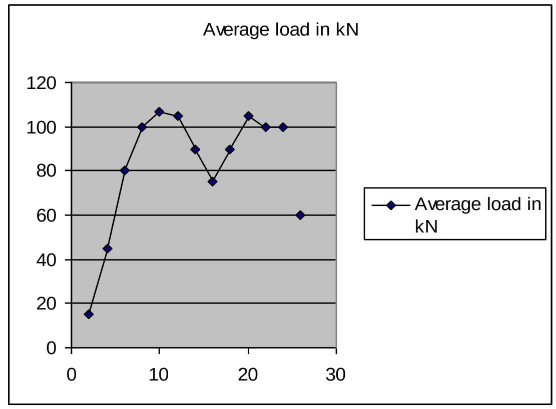
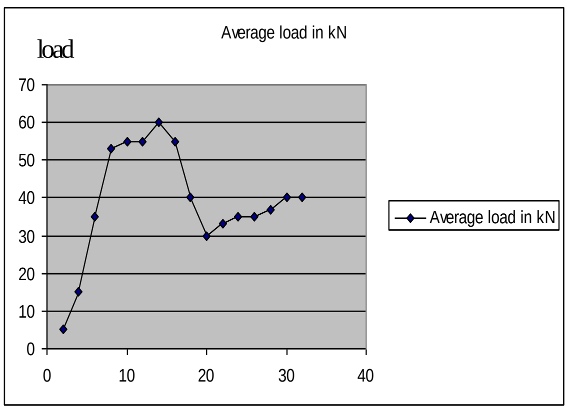


Fig 11: Compressive load – Time graph of box beam for Agba species Fig 12: Compressive load – Time graph of box beam for Okan species



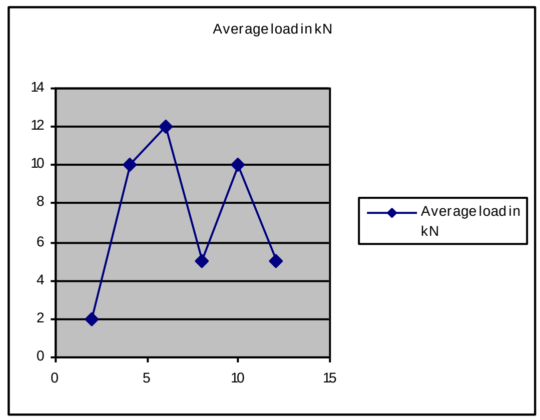


Fig 13: Compressive load – Time graph of box beam for Danta species Fig 14: Compressive load – Time graph of box beam for Afara species.

4. Discussion and Deductions

The following deductions can be made:

i. In the longitudinal warping rate, the ranges of rate of warping are Danta (0.33 % to 1.67%) , Okan (0.5% to 1.22%), Agba (0.33% to 0.83%) and Afara (0.05% to 0.83%) in their descending order . See fig.1 **and** fig.2.

ii. In the lateral warping rate, the ranges of rate of warping are Okan (0.03 % to 2.33%), Danta (0.11% to 1.0%), Agba (0.11% to 1.0%) and Afara (0.06 to 0.11%) in their descending order. See fig .3 and fig.4.

iii. In the radial warping rate, the ranges of rate of warping are Danta (0.5% to 1.34%),Agba (0.11% to 1.33%),Okan (0.03% to 1.33%), and Afara (0.06 % to 1,33%) also in their descending order. See fig.5 and fig.6.

iv. The racking forces in the flexural box beams tests are Okan (95kN), Danta (74kN), Afara (45kN),and Agba (31kN) in their descending order. See fig.7,fig.8, fig.9 and fig.10.The racking force in the compressive box beams tests are Okan(107kN), Danta (60kN), Agba(50kN),and Afara(12kN) in their descending order. See fig.11, fig.12, fig.13 and fig.14.

A procedural testing of natural warping, and bending was done by carrying out investigation of pure bending of box beams using a compressive strength testing machine of maximum designed strength of 2500kN and carrying out investigation of pure bending of box beams using a flexural testing machine of maximum designed strength of 100kN. Consequently, fabrication of box beams was done.. An analysis was done to compare values obtained from the analytical method and the experimental values. It was observed that the test results from different species were in correlation with the analytical method. In the longitudinal warping rate, the ranges of rate of warping are Danta(0.33 % to 1.67%) , Okan (0.5% to 1.22%), Agba (0.33% to 0.83%) and Afara (0.05% to 0.83%) in their descending order. In the lateral warping rate, the ranges of rate of warping are Okan (0.03 % to 2.33%), Danta (0.11% to1.0%), Agba (0.11% to 1.0%) and Afara (0.06 to 0.11%) in their descending order. In the radial warping rate, the ranges of rate of warping are Danta (0.5% to 1.34%),Agba (0.11% to 1.33%),Okan (0.03% to 1.33%), and Afara (0.06 % to 1,33%) also in their descending order. The racking forces in the flexural box beams tests are Okan(95kN), Danta (74kN), Afara(45kN),and Agba(31kN) in their descending order. The racking force in the compressive box beams tests are Okan(107kN), Danta (60kN), Agba(50kN),and Afara(12kN) in their descending order. From the graphs plotted, the jagged effect experienced by the box beam distortion can be seen on figures 7, 8 ,9 ,10 ,11 ,12 , 13 , 14. The towards failure being caused by the progressive splitting of the extreme tension fibres shows that before the ultimate racking force, the box beam has been acting as a monolithic system, thus it resists the maximum force before failure occurs. The renewed increase in strength in all the graphs which tends towards the near maximum, but not the ultimate occurs due to the resistance offered by the fibrous material of the each timber species. Again invariably this is an indirect method of assessing the resistibility of individual species and its particular fibrous material. It can be stated therefore that for the four species tested, their fibrous resistibility are given in this descending order : Okan, Agba, Danta and Afara. This study has confirms the fact that warping and distortion of timbers equally vary with different species. This confirms reports by Jackson and Dhir. From load – distortion figures 7 to 14, it can be seen that the response pattern equally appears elastically until it was observed that beyond the racking force, the maximum distortion has occurred and this is sustained even as the loading continues.

5. Conclusion

The experimental analysis of warping torsion and bending in timber box beams has been verified and the initial warping of the timber web beams has been seen to affect the warping of box beam constructed with it. Also the fibrous materials respond differently both in box beams and thus produces different physical and material stress jaggered effects. The jagged effect experienced by the box beams the towards failure is caused by the progressive splitting of the extreme tension fibres shows that before the ultimate racking force, the box beam has been acting as a monolithic system, thus it resist the maximum force before failure occurs, the renewed increase in strength which tends towards the near maximum, but not the ultimate occurs due to the resistant offered by the fibrous material of the timber species. This is an indirect method of accessing the resistibility of individual species fibrous material, it can be stated therefore that for the four species tested their fibrous resistibility are given in their descending order :Okan ,Agba , Danta and Afara. This study has confirmed that distortion of timber beams is equally varies with different species since each species response differently whether in isolation or in fabricated box beams.

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