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Tribological Properties of Some Locally Manufactured Abrasive Wheels

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Abstract
Abrasive wheels are used for smoothening, machining or in some cases, roughening another softer material through extensive rubbing. This research work is targeted to designing and fabricating of some abrasive wheels using locally available materials. Six different modules of the abrasive wheel where designed, moulded and tested. Module number five was found to manifest the best in performance and mechanical strength.
Keywords: Abrasives, composition, Strengths, compression, deflection.

1. Introduction

Abrasive can be a wheel, disc, or cone which whether or not any other material is comprised and it consist of abrasive particles held together by material, metallic or organic bonds whether natural or artificial. Various types of abrasives are used in abrasive wheels, as appropriate to the type of work they are designed for. Silicon carbide abrasive is harder, more brittle than aluminium oxide abrasive making them particularly suitable for grinding, low tensile strength materials like cast iron, stone, non-ferrous metals and non-metallic materials. Diamond abrasive wheel was used for grinding brinks, sharpening tools and precision tools. Mixed abrasive wheels are noted for their wide range of characteristics. [2]

This work experiments for some locally available materials such as palm kernel shell, gravel, metal chips, snail shell pellets, granite and bottle pellets for the production of abrasive wheels.

2. Materials and Method

The materials for the abrasives were carefully selected. Each material was grounded to the appropriate sizes. The sizes of patterns were prepared for moulding the material. A 1.7 micron sieve was used for sieving the material. Sieved materials were measured using a sensitive weighing machine. Each module was mixed and the binder added. After proper mixing with the binder, the mixture was poured into the pattern and ramming is done for compaction [1, 4]. Both the pattern and mixed materials was dried in an oven in order to cure and then the product was separated from the pattern [5]. Tables 1A, 2A, 3A, 4A, 5A, and 6A are the measurement by weight and the percentage composition of the material for each designed module respectively. Each of the modules was tested to determine its mechanical strengths.

MODULE ONE	IN PERCENTAGE	IN GRAM
Bottle pellets as parent material	30%	300g
Gravel	25%	250g
Palm kernel shell	15%	150g
Snail shell	10%	100g
Granite	10%	100g
Metal chips	10%	100g
Total	100%	1000g

Table 1A: Measurements by percent composition of module I

MODULE TWO	IN PERCENTAGE	IN GRAM
Palm kernel shell, as parent material	30%	300g
Bottle pellet	15%	150g
Gravel	25%	250g
Snail shell	5%	50g
Granite	10%	100g
Metal chips	15%	150g
Total	100%	1000g

Table 2A: Measurements by percent composition of module II

MODULE THREE	IN PERCENTAGE	IN GRAM
Gravel as parent material	30%	300g
Bottle pellet	25%	250g
Palm kernel shell	15%	150g
Snail shell	5%	50g
Granite	10%	100g
Metal chips	15%	150g
Total	100%	1000g

Table 3A: Measurements by percent composition of module III

MODULE FOUR	IN PERCENTAGE	IN GRAM
Granite as parent material	30%	300g
Bottle pellet	15%	150g
Gravel	20%	200g
Palm kernel shell	15%	150g
Snail shell	5%	50g
Metal chips	15%	150g
Total	100%	1000g

Table 4A: Measurements by percent composition of module IV

MODULE FIVE	IN PERCENTAGE	IN GRAM
Metal chips as parent material	25%	250g
Granite	20%	200g
Bottle pellet	20%	200g
Gravel	20%	200g
Palm kernel shell	10%	100g
Snail shell	5%	50g
Total	100%	1000g

Table 5A: Measurements by percent composition of module V

MODULE SIX	IN PERCENTAGE	IN GRAM
Snail shell as parent material	25%	250g
Bottle pellet	20%	200g
Gravel	20%	200g
Palm kernel shell	20%	200g
Granite	10%	100g
Metal chips	5%	50g
Total	100%	1000g

Table 6A: Measurements by percent composition of module VI
Source: Authors' field work

3. Results and Discussion

The test conducted at FIIRO in Nigeria, using compressive strength testing machine on second October in year 2013 for samples/module of circular discs compressed at 30mm/min without any pre-load is presented in tables 1B, 2B, 3B, 4B, 5B and 6B. For example for sample 5 or module 5 having wheel diameter 50.550mm the force at break; the stress at break was 4956N; 2.4694N/mm^2 and 14.17N-m respectively. Values of force at yield stress at yield, energy to yield, young Modulus, deflection at peak and deflection at break for sample five/module 5 were taken as 4581N, 2.28N/mm^2, 7.1184N-m, 54.56N/mm^2, 6.06mm and 6.07mm. The graphs of applied forces versus the deflection in mm of each wheel are as presented by fig 1, 2, 3, 4, 5 and 6 respectively.

Table 1B: Test Result for module 1

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Serial : COMPOSITE                               Test : Compressive strength
Batch : MODULE 1                                 Test Type : Compression
Deflection :                                     Date : 02-10-13
Operator : FIIRO                                 Test Speed : 030.00mm/min
                                                 Test Speed 2 : NONE
                                                 Sample Type : CIRCULAR
                                                 Pre-Load : OFF
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Test No.	Height mm	Diameter mm	Force @ Peak N	Stress @ Peak N/mm²	Energy to Peak N.m	Force @ Break N	Stress @ Break N/mm²	Energy to Break N.m
1	46.210	50.550	1177.7	0.5868	3.9492	1091.7	0.5440	7.3769

Test No.	Force @ Yield N	Stress @ Yield N/mm²	Energy to Yield N.m	Youngs Modulus N/mm²	Def. @ Peak mm	Def. @ Break mm
1	1177.7	0.5868	3.9822	7.8802	7.3140	10.334

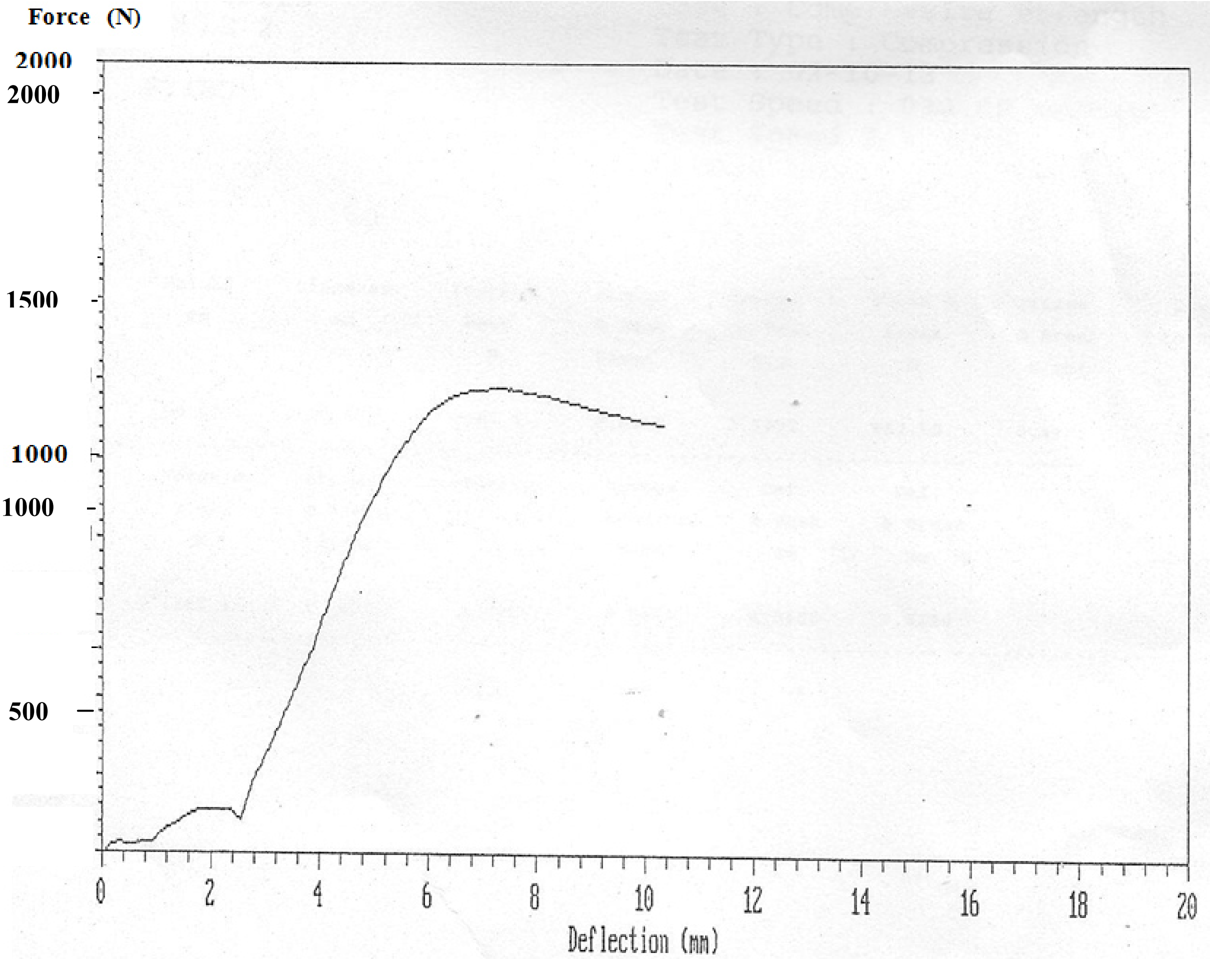

Fig. 1 Graph of Deflection for module 1

Fig. 1 Graph of Deflection for module 1

Table 2B: Test Result for module 2

Serial : COMPOSITE
Batch : MODULE 2
Deflection :
Operator : FIIRO

Test : Compressive strength
Test Type : Compression
Date : 02-10-13
Test Speed : 030.00mm/min
Test Speed 2 : NONE
Sample Type : CIRCULAR
Pre-Load : OFF

Test No.	Height mm	Diameter mm	Force @ Peak N	Stress @ Peak N/mm²	Energy to Peak N.m	Force @ Break N	Stress @ Break N/mm²	Energy to Break N.m
1	59.670	50.550	1287.4	0.6415	2.5997	957.50	0.4771	4.4908

Test No.	Force @ Yield N	Stress @ Yield N/mm²	Energy to Yield N.m	Youngs Modulus N/mm²	Def. @ Peak mm	Def. @ Break mm
1	1287.4	0.6415	2.5997	8.5594	6.0450	7.6290

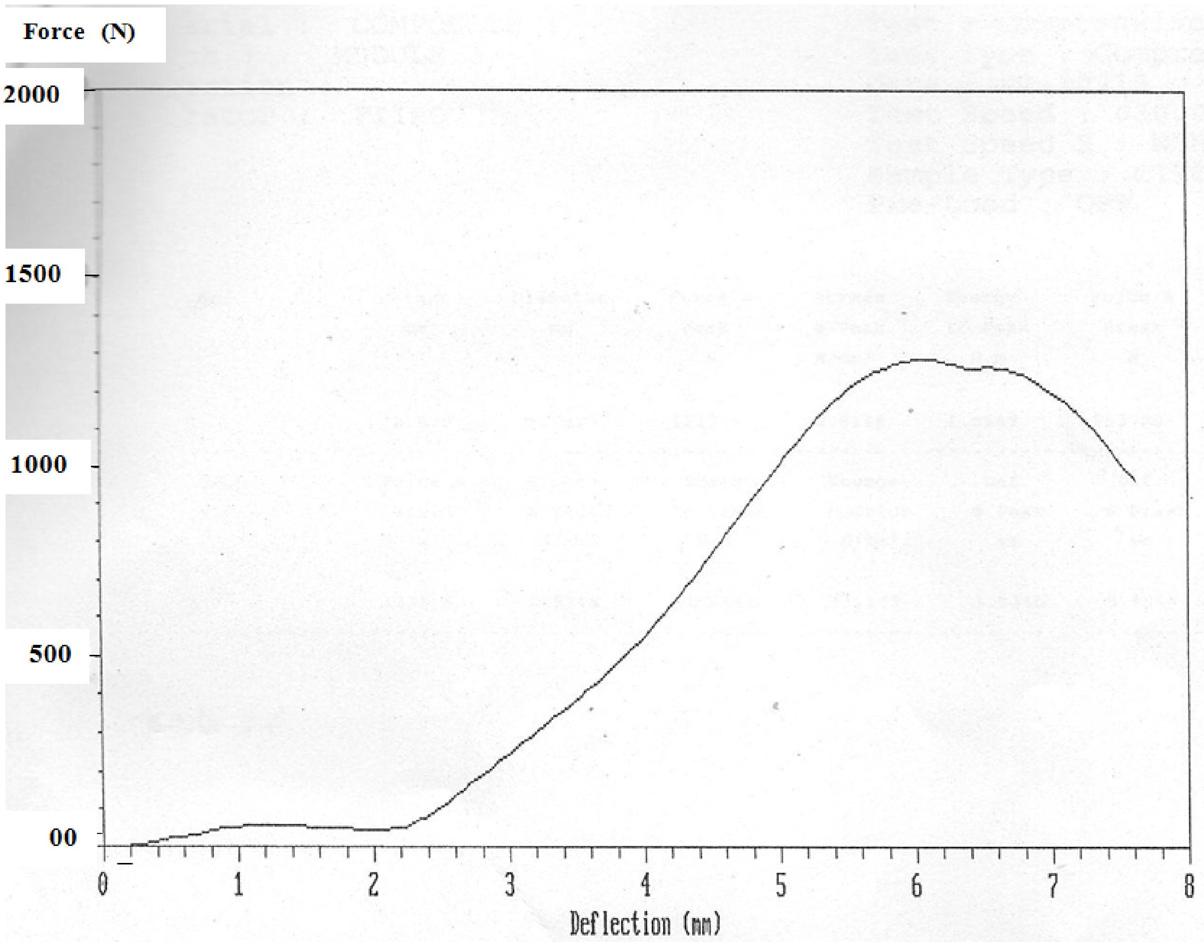

Fig. 2 Graph of Deflection for module 2

Table 3B: Test Result for module 3

Serial : COMPOSITE
Batch : MODULE 3
Deflection :
Operator : FIIRO

Test : Compressive strength
Test Type : Compression
Date : 02-10-13
Test Speed : 030.00mm/min
Test Speed 2 : NONE
Sample Type : CIRCULAR
Pre-Load : OFF

Test No.	Height mm	Diameter mm	Force @ Peak N	Stress @ Peak N/mm²	Energy to Peak N.m	Force @ Break N	Stress @ Break N/mm²	Energy to Break N.m
1	70.570	50.550	1233.5	0.6416	1.6649	553.00	0.2755	4.3464

Test No.	Force @ Yield N	Stress @ Yield N/mm²	Energy to Yield N.m	Youngs Modulus N/mm²	Def. @ Peak mm	Def. @ Break mm
1	1233.5	0.6145	1.6649	33.105	3.9260	6.8940

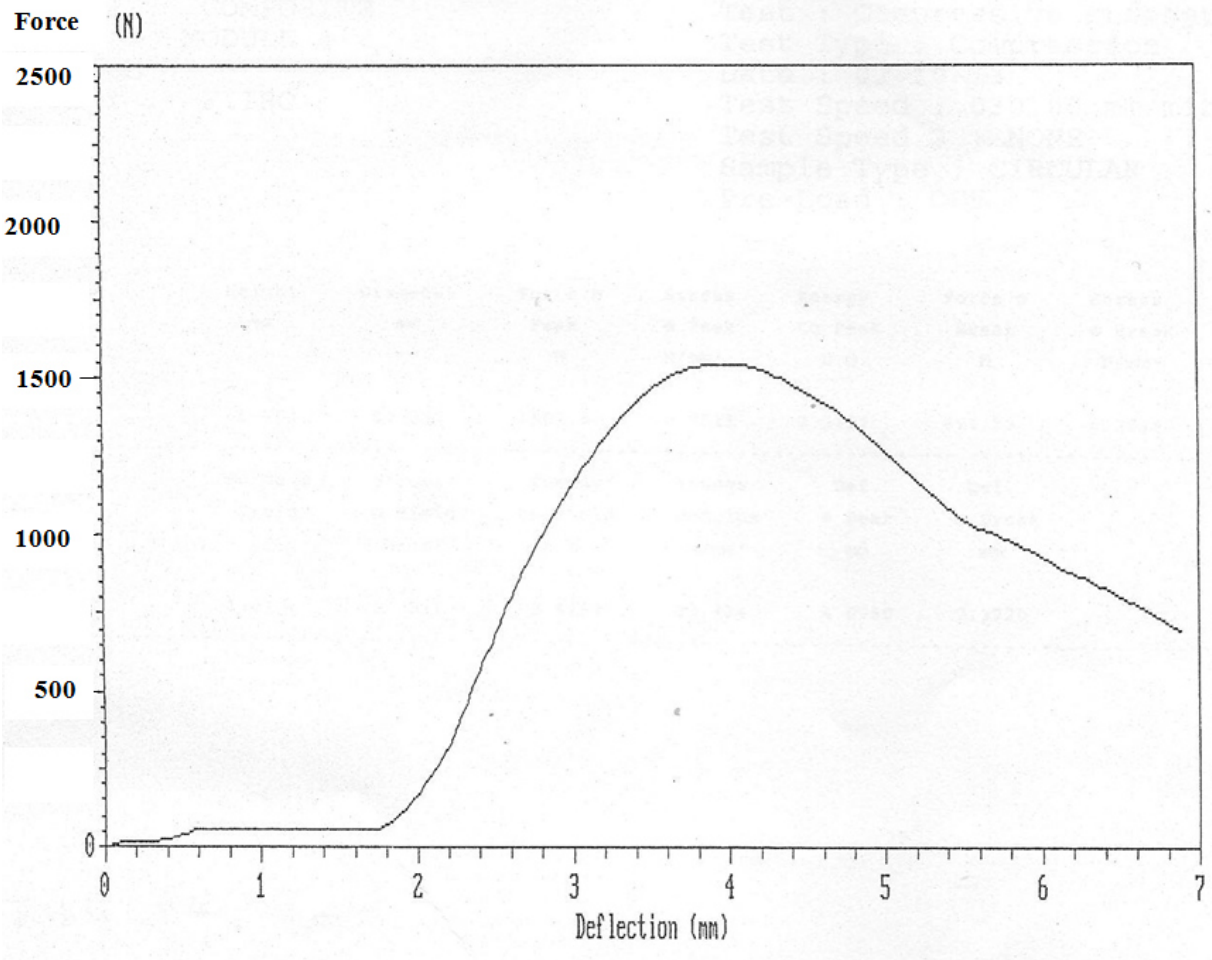

Fig. 3 Graph of Deflection of module 3

Table 4B: Test Result for module 4

Serial : COMPOSITE
Batch : MODULE 4
Deflection :
Operator : FIIRO

Test : Compressive strength
Test Type : Compression
Date : 02-10-13
Test Speed : 030.00mm/min
Test Speed 2 : NONE
Sample Type : CIRCULAR
Pre-Load : OFF

Test No.	Height mm	Diameter mm	Force @ Peak N	Stress @ Peak N/mm²	Energy to Peak N.m	Force @ Break N	Stress @ Break N/mm²	Energy to Break N.m
1	66.790	50.550	1507.4	0.7511	2.5157	591.20	0.2946	5.1629

Test No.	Force @ Yield N	Stress @ Yield N/mm²	Energy to Yield N.m	Youngs Modulus N/mm²	Def. @ Peak mm	Def. @ Break mm
1	1507.4	0.7511	2.5157	22.424	4.6950	7.3720

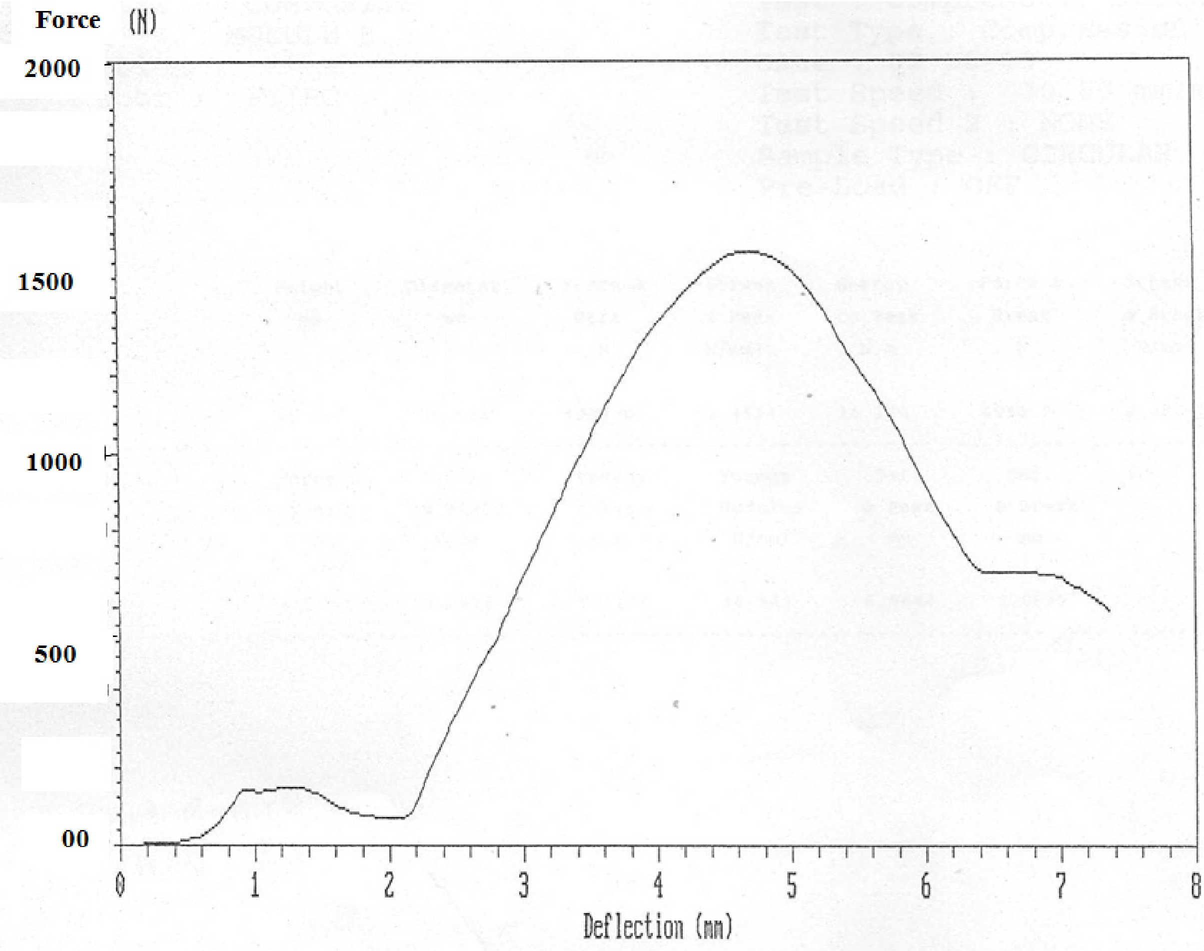

Fig. 4 Graph of Deflection for module 4

Table 5B: Test Result for module 5

Serial : COMPOSITE	Test : Compressive strength
Batch : MODULE 5	Test Type : Compression
Deflection :	Date : 02-10-13
Operator : FIIRO	Test Speed : 030.00mm/min
	Test Speed 2 : NONE
	Sample Type : CIRCULAR
	Pre-Load : OFF

Test No.	Height mm	Diameter mm	Force @ Peak N	Stress @ Peak N/mm²	Energy to Peak N.m	Force @ Break N	Stress @ Break N/mm²	Energy to Break N.m
1	45.590	50.550	4956.0	2.4694	14.170	4956.0	2.4694	14.170

Test No.	Force @ Yield N	Stress @ Yield N/mm²	Energy to Yield N.m	Youngs Modulus N/mm²	Def. @ Peak mm	Def. @ Break mm
1	4581.0	2.2826	7.1184	54.563	6.0680	6.0680

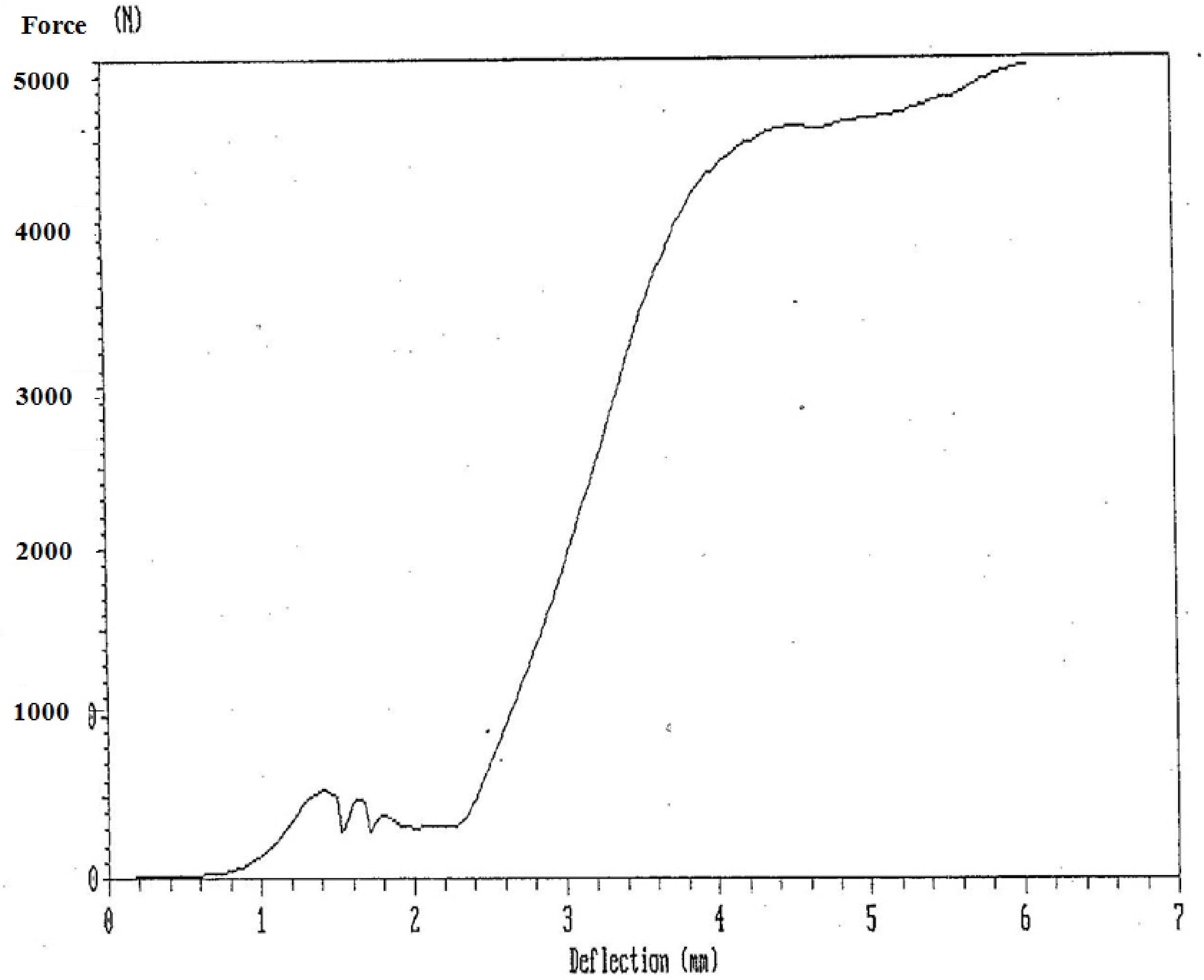

Fig. 5 Graph of Deflection for module 5

Table 6B: Test Result for module 6

Serial : COMPOSITE	Test : Compressive strength
Batch : MODULE 6	Test Type : Compression
Deflection :	Date : 02-10-13
Operator : FIIRO	Test Speed : 030.00mm/min
	Test Speed 2 : NONE
	Sample Type : CIRCULAR
	Pre-Load : OFF

Test No.	Height mm	Diameter mm	Force @ Peak N	Stress @ Peak N/mm²	Energy to Peak N.m	Force @ Break N	Stress @ Break N/mm²	Energy to Break N.m
1	66.560	50.550	1421.5	0.7083	2.2842	502.40	0.2503	9.0661

Test No.	Force @ Yield N	Stress @ Yield N/mm²	Energy to Yield N.m	Youngs Modulus N/mm²	Def. @ Peak mm	Def. @ Break mm
1	1421.5	0.7083	2.2842	29.924	4.9360	12.736

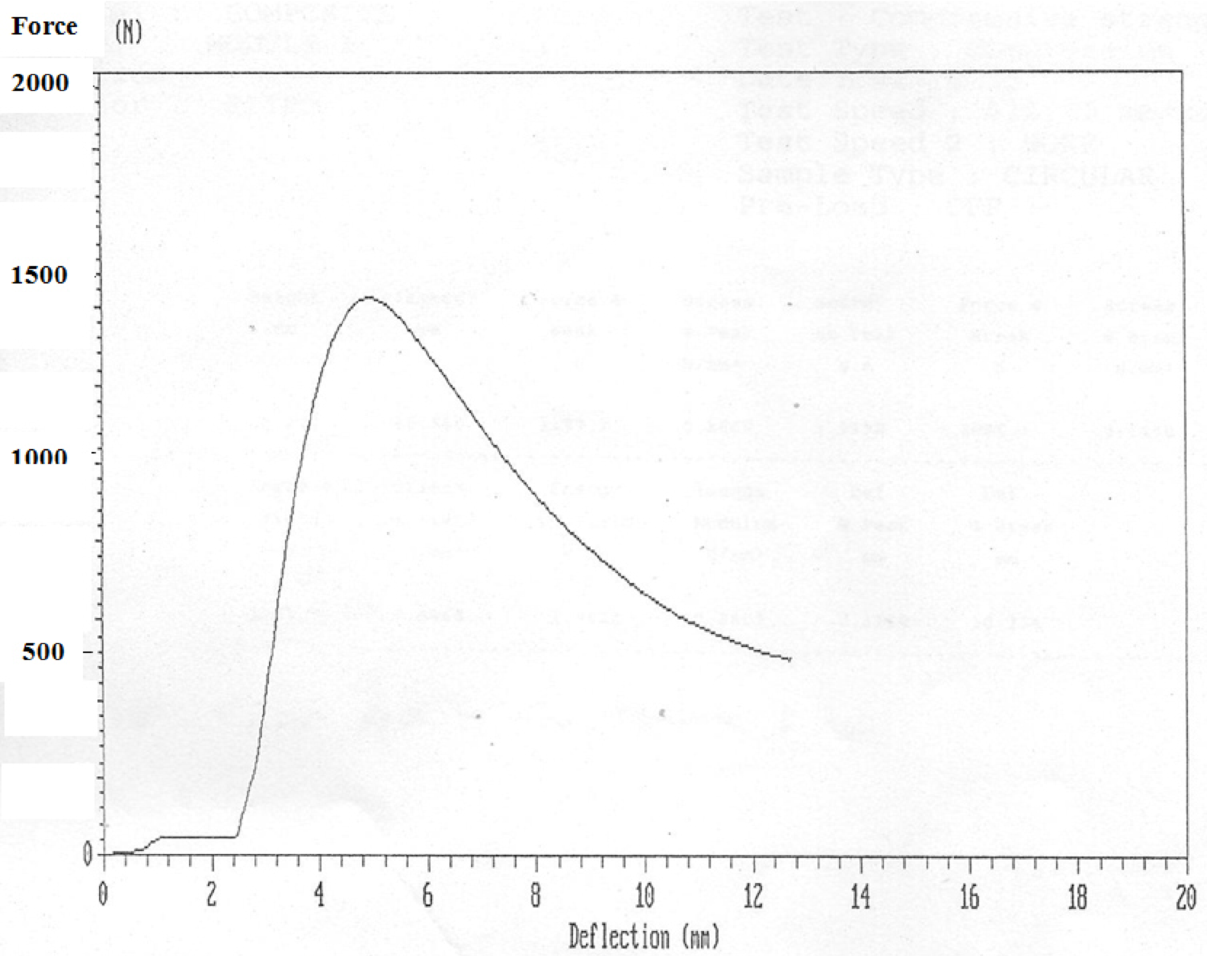

Fig. 6 Graph of Deflection for module 6

4. Conclusion

The research was well conducted to determine the various parameters of each of the abrasive wheels. Based on the test carried out of the samples, module 5 was found to exhibit the greatest strength and performance for chips removal, sanding, and grounding applications. Each of the wheels produced can be improved upon for better performance and they are all cheaper and cost effective.

5. References

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