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COMPRESSIBILITY OF SOME MADE-IN-NIGERIA FOAM MATTRESSES

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ABSTRACT

The compressibility of various made – in - Nigeria foam mattresses were tested by measuring the rigidity moduli of different foams obtained from five major foam-manufacturing industries with the aim of ascertaining the extent of their conformity with the Nigeria Industrial Standard (NIS) specification. The results obtained indicate that only 20% of the sample foams investigated statistically satisfy the NIS recommended value. It is thus recommended that the NIS should monitor and regulate the various companies involved in the production of foam mattresses in the country.

KEYWORDS: compressibility, made – in --Nigeria foam mattresses, NIS specification

INTRODUCTION

The era of sleeping with mats either on the ground or on metal and/or wooden beds in most communities in Nigeria can be considered to have gone into history as most homes now can afford to purchase sleeping foams. Foam flexibility is characterized by low compressive modulus. The degree of compressibility of a particular foam mattress is an important factor that should be considered in foam production since it has bearing with the comfort and health of the end users as well as the life span of the product itself (AHCPRI, 2000). In health care, it is required that sinking the body into a material (foam) will evenly disperse pressure over the entire weight-bearing surface. Too much immersion will cause increased pressure on bony prominences that might result in pressure ulcers. Thus the ability of a surface to immerse a body must be balanced with its ability to support that body from bottoming out. Professionally, the ratio of the (65% to the 25%) Indentation Load Deflection (ILD) balances the immersion capabilities of a given foam.

In Nigeria today, there are diverse sleeping foams available in the market and a number of foam producing companies with Vita foam Nig. Plc having about 40% of the market as at 1994 (UNIDO, 1995). What is not certain is whether or not the various foam mattresses produced in the country meet the $35.6x10^2Nm^{-2}\ rad^{-1}$ standard set by the Nigeria Industrial Standard (NIS, 1987). It is therefore intended in this investigation to verify whether or not made in Nigeria foam mattresses conform to this stipulation.

MATERIALS AND METHODS

Sample foams obtained from five major foam producing industries were kept in the physical science laboratory of the department of Physics Delta State University, Abraka for a period of one month to ensure that the samples were exposed to the same environmental conditions. They were then trimmed to the same dimensions of length, width and thickness. Each sample was subsequently clamped to an elastometer (figure 1) improvised in the said laboratory for the purpose of this investigation and then subjected to varying compression stresses F_i, by means of known weights hung from an overlaying plywood piece, PP as illustrated in figure 1. The plywood piece not only ensured uniform compression on the foams but also prevented the foams from tearing apart during loading.

The angular depressions Φ_i were noted both at the loading and unloading stages so that the mean depressions $\overline{\Phi}_i$ were determined. These depressions were determined using the trigonometric relationship:

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$$\Phi_i = \tan^{-1}\left(\left[\frac{a}{b}\right]_i\right) \qquad [1]$$

a_i represents the vertical depression (in m) of the foam as a result of the application of the compression force F_i (in N) and b, its width also (in m).

The rigidity modulus for a particular sample for varying compressions was calculated from the equation (Tyler, 1981):

$$M_i = \left(\frac{\frac{F}{A}}{\overline{\Phi}_i}\right)_i \qquad [2].$$

$\left(\frac{F}{A}\right)_i$ represents the shear stress that is the ratio of the applied force to the area of the foam sample. The values of F_i were obtained by summing up all applied known weights and the weight of the overlaying plywood piece; PP. $\overline{\Phi}_i$ is the mean angular depression in radians. Equation [2] above which can be written as:

$$\left(\frac{F}{A}\right)_i = M_i\overline{\Phi}_i \qquad [3],$$

enabled the measured values of the shear stresses to be plotted against the angular displacements. The modulus of rigidity for each foam sample was then determined from the slopes of the various plots and tested statistically using the χ^2 statistics (Welkowitz et al, 1988) for conformity or otherwise to the NIS recommended value.

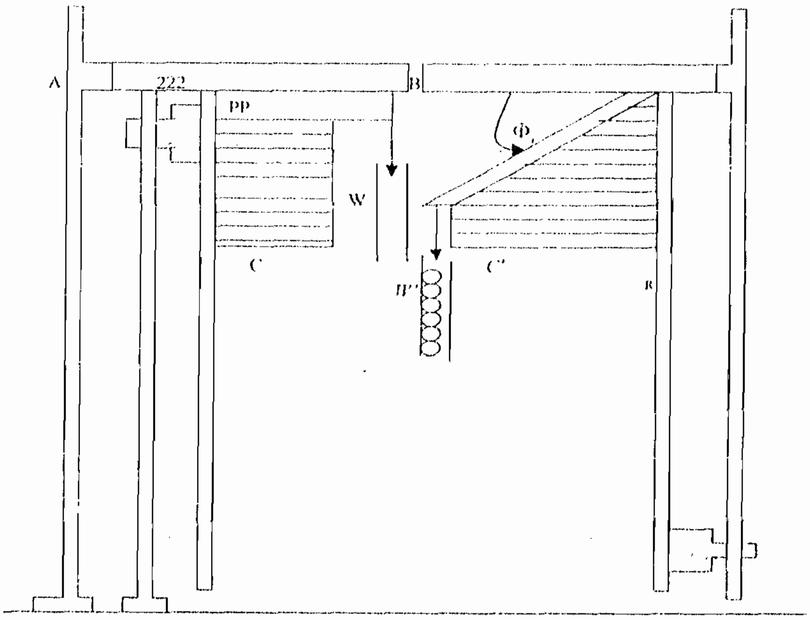

Fig. 1: Experimental Setup

A=Retort stand; B= A graduated plywood piece; C= Uncompressed foam;

C''=Compressed foam; W= Empty weight holder; W''= Weights; R= Metre rule.

RESULTS AND DISCUSSIONS

Tables 2 and 3 present the values of the mean angular depressions $\overline{\Phi}_i$ for varying shear stresses for two values of thickness t=0.05m and t=0.075m of the sample foams.

Table 1: Mean angular depressions for varying shear stresses (t=0.05m)

Shear Stress (Nm^{-2})	Mean angular depression $\overline{\Phi}_i$ (rad) for the five foam samples				
	F1	F2	F3	F4	F5
96.59	0.032	0.016	0.032	0.040	0.024
141.59	0.088	0.048	0.096	0.112	0.072
284.15	0.153	0.080	0.177	0.185	0.112
377.93	0.234	0.104	0.267	0.309	0.161
471.7'	0.301	0.136	0.351	0.420	0.218
565.49	0.368	0.169	0.474	0.537	0.275
659.27	0.456	0.218	0.594	0.644	0.326

Table 2: Mean angular depressions for varying shear stresses (t=0.075m)

Shear Stress (Nm^{-2})	Mean angular depression $\overline{\Phi}_i$ (rad) for the five foam samples				
	F1	F2	F3	F4	F5
103.26	0.016	0.016	0.088	0.032	0.016
203.52	0.032	0.032	0.193	0.088	0.040
303.77	0.096	0.048	0.368	0.177	0.080
404.29	0.161	0.072	0.510	0.343	0.120
504.29	0.267	0.096	0.614	0.447	0.169
604.54	0.368	0.112	0.737	0.538	0.234
704.80	0.447	0.128	0.815	0.585	0.292

The mean angular depressions $\overline{\Phi}_i$ (rad) for the foam samples of thickness t = 0.05m range from (0.016 to 0.644) rad. The t= 0.075m thickness samples require greater shear stresses for identifiable compressions. Their mean angular depressions range from (0.016 to 0.815) rad. Figures 2 and 3 represent the plots of shear stress F_i(Nm^{-2}) against the mean angular depressions $\overline{\Phi}_i$ (rad) for t= 0.075 and t = 0.075m respectively. Each pair of plots shows the same linear trend but however varies in both the slope (rigidity modulus) and R^2 values that is their coefficients of variation.

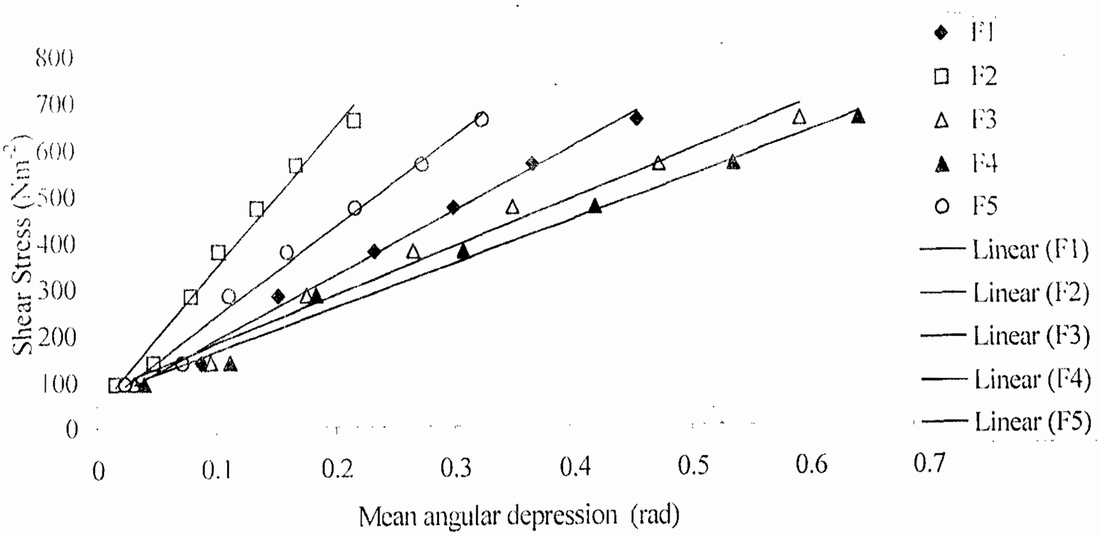

Fig. 2: Shear stress F_i against angular depression $\overline{\Phi}_i$ for the (t=0.05m) foam samples

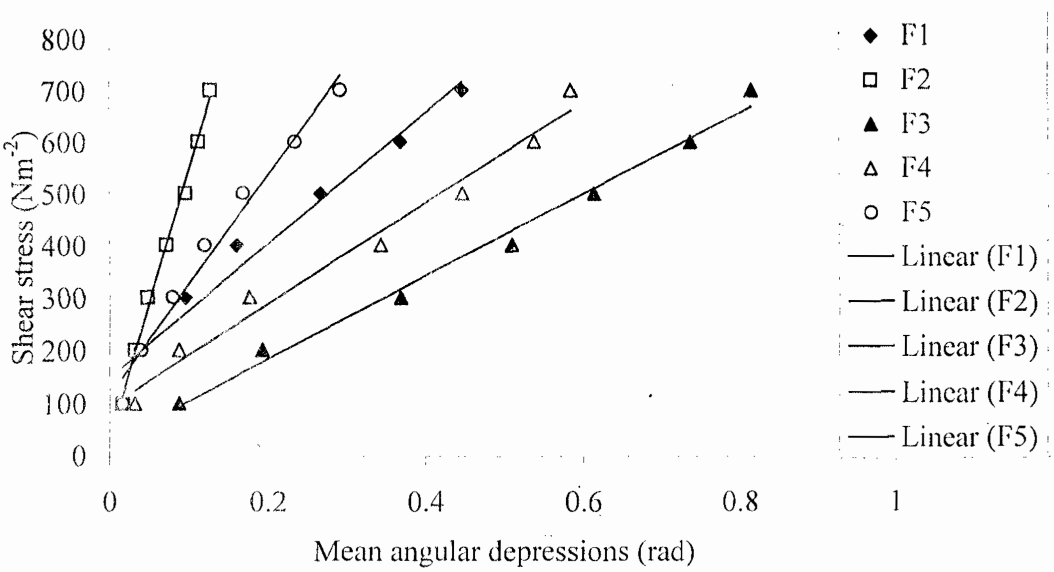

Fig. 3: Shear stress F_i against angular depression $\overline{\Phi}_i$ for the (t = 0.075m) foam samples

The equations and the R^2 values for each plot are given in Table3. The R^2 values are each approximately equal to 1($R^2 \sim 1$) depicting the consistency of the values.

Table 3:Equations of the pair of graphs showing the slope (compressibility) and R^2 values

Foam sample	t = 0.05m	t = 0.075m
F1	$F_s = 1372.9\Phi + 50.875 : R^2 = 0.99$	$F_s = 1273.5\Phi + 151.53 : R^2 = 0.97$
F2	$F_s = 2982.9\Phi + 42.412 : R^2 = 0.98$	$F_s = 5133.6\Phi + 34.41 : R^2 = 0.99$
F3	$F_s = 1039.3\Phi + 78.198 : R^2 = 0.98$	$F_s = 790.97\Phi + 28.321 : R^2 = 0.99$
F4	$F_s = 933.15\Phi + 71.419 : R^2 = 0.99$	$F_s = 973\Phi + 96.84 : R^2 = 0.98$
F5	$F_s = 1912.4\Phi + 46.406 : R^2 = 0.99$	$F_s = 2109\Phi + 117.51 : R^2 = 0.98$

CONCLUSIONS

The mean rigidity moduli (compressibility) obtained for these samples range from (9.11 to 38.17) x10^2 Nm^{-2} rad^{-1}. χ^2 statistics show that of the sample foams investigated, only the rigidity compression value obtained for sample F2 is statistically the same as the NIS recommended value within 95% confidence limit. This represents 20% of the lot.

REFERENCES

AHCPRI, 2000. Agency for Healthcare Policy and Research. US Department of Health and Human Services

NIS, 1987. Nigeria Industrial Standard .Specification for Flexible Urethane foam for load bearing applications. Nigeria Industrial Standard Publishers.

Tyler, H. A., 1981. Science and Materials, level III. Van Nostrad and Reinhold Company Ltd.

UNIDO, 1995. United Nations Industrial Development Organization. Final Report on Preparation of CFC Phase- out Strategy for Refrigeration and Air-conditioning Industries and Services in Nigeria. UNIDO, Vienna.

Welkowitz, J., Ewer, R. B., and Cohen, J., 1988. Introductory Statistics for the Behavioral Sciences. Harcourt Brace Jovanovich Publishers.