AN EXPERIMENTAL INVESTIGATION OF MECHANICAL PROPERTIES OF LOCALLY MANUFACTURED PVC PIPE

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Abstract An experimental investigation of some important mechanical properties of locally manufactured polyvinyl chloride (PVC) pipes have been performed. Out of many mechanical properties, the most important mechanical properties such as, tensile strength, percentage elongation and hardness have been taken into consideration for investigation.

Keyword: Mechanical properties, PVC

INTRODUCTION

Now-a-days PVC pipes are being widely used for many household and industrial applications. For transportation of pressurized water and other liquids, they are being used extensively. As such, it has become important to test its mechanical properties with a view to ascertaining whether they are suitable for the required application.

At the moment, there are a large number of PVC industries in Bangladesh. Among them the product of a particular industry has been selected to study its most important mechanical properties such as, tensile strength, percentage elongation and hardness. Reasonable number of samples were considered for experiment in order to perform statistical analysis.

For many reasons, the PVC industry can not maintain the quality of its product according to international standard i.e. ASTM, BS etc. This idea has created interest to conduct experimental investigation of mechanical properties. It could have been a good work if almost all the locally available PVC products of different industries, could be taken into consideration for the investigation. As a preliminary step only product of one industry has been chosen avoiding the huge work. However, in course of time the products of other industries shall be taken into consideration for the study.

The study has been conducted in accordance with the ASTM standard. For the determination of tensile strength and percentage elongation a universal testing machine of 10-ton capacity is used. Rockwell hardness testing machine is used for determination of ball indentation hardness.

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STATISTICAL PARAMETERS

Mean: If x_1, x_2, x_2, ... x_N represent the values of N samples then the sample mean is computed from the relation,

$$\mu = \frac{\sum_{i=1}^{N} x_i}{N} \qquad (1)$$

Standard Deviation: The expression of the sample variance can be obtained as,

$$\sigma_x^2 = \frac{(x_1 - \mu)^2 + (x_2 - \mu)^2 + .. + (x_N - \mu)^2}{N-1} = \frac{1}{N-1}\sum_{1}^{N} (x_j - \mu)^2 \qquad (2)$$

The sample standard deviation can be written as,

$$\sigma_x = \left[\frac{1}{N-1}\sum_{1}^{N} (x_j - \mu)^2\right]^{\frac{1}{2}} \qquad (3)$$

Normal distribution Curve: The most important continuous probability distribution in the entire field of statistics is the normal distribution. If x is the normal

random variable with mean μ and variance σ^2, then the expression of the normal distribution curve is,

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \quad -\infty < x < +\infty \qquad (4)$$

Ball Indentation Hardness:
According to DIN 53 456 ball indentation hardness is measured. The expression of ball indentation hardness is,

$$H = \frac{0.21}{0.`21 - h_r + h} . \frac{F}{5\pi h_r} \left(N/mm^2\right)$$

Where,
F is the test force in Newton
h_r is the reduced indentation depth = 0.25mm
h is the indentation depth in mm.

RESULTS AND DISCUSSION

Figure 1 shows the histogram of tensile strength values.

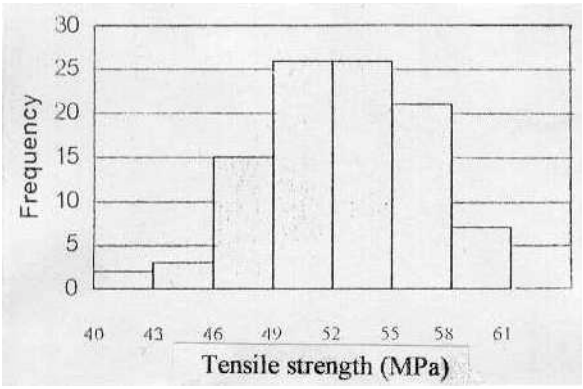

Fig. 1 Histogram of Tensile Strength values

The mean and the standard deviation of the 100 samples chosen for the experiment are respectively 52.32 MPa and 3.92 MPa. They satisfy the standard value of the PVC material.

Figures 2 and 3 respectively show the frequency polygon and the cumulative frequency of tensile strength values.

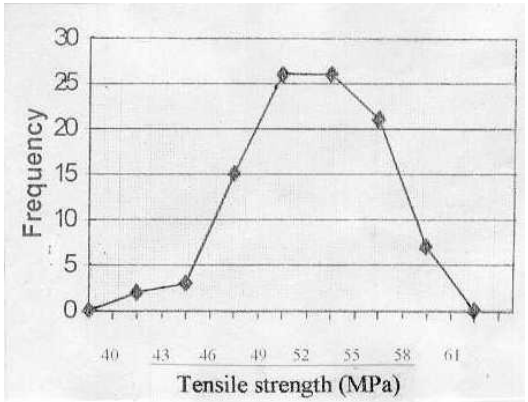

Fig. 2 Frequency Polygon of Tensile Strength

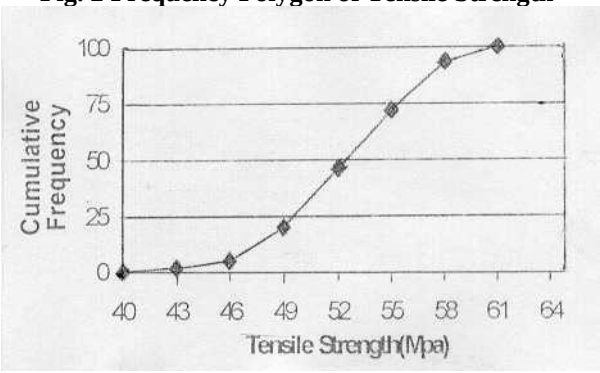

Fig. 3 Cumulative Frequency of Tensile Strength

The normal distribution curve of tensile strength values can be seen in the figure 4.

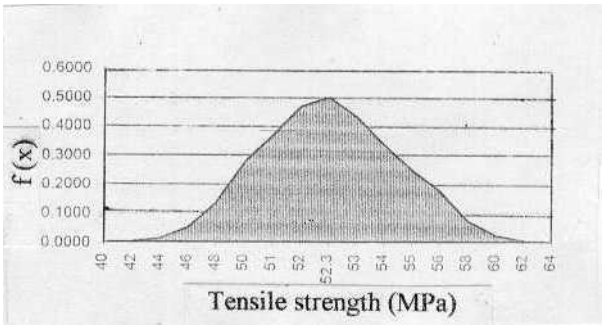

Fig. 4 Normal Distribution Curve of Tensile Strength Values

The histogram. frequency polygon, cumulative frequency and normal distribution of percentage elongation have been shown in the figures 5, 6, 7 and 8 respectively. The mean and the standard deviation values of percentage elongation are respectively 17.09 and 4.94. The value of the percentage elongation obtained is lower than the minimum value of the standard range of PVC material.

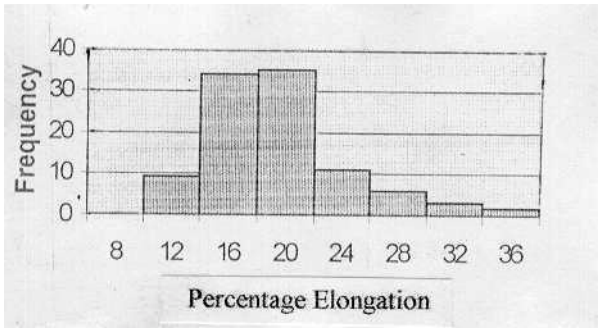

Fig. 5 Histogram of Percentage Elongation

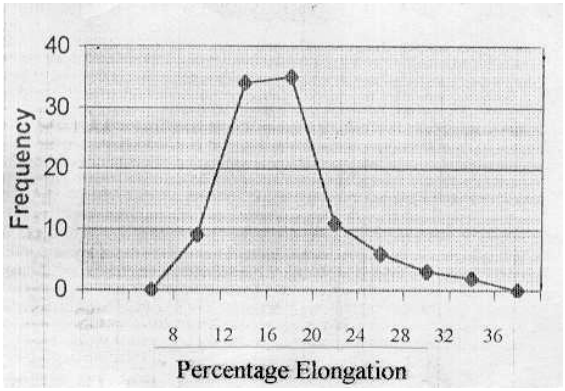

Fig. 6 Frequency Polygon of Percentage Elongation

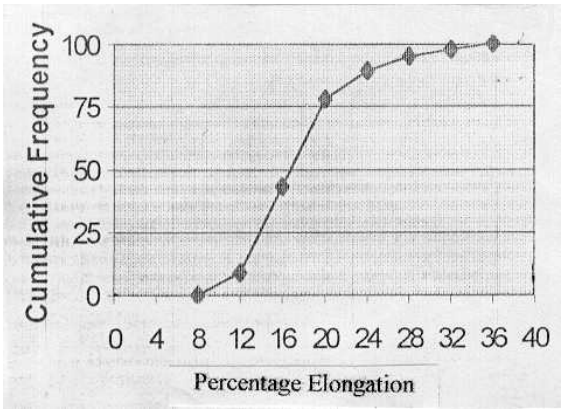

Fig. 7 Cumulative Frequency of Percentage Elongation

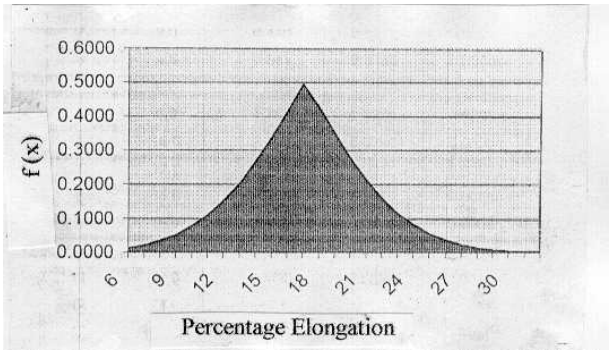

Fig. 8 Normal Distribution Curve of Percentage Elongation

The Figures 9, 10, 11 and 12 respectively show the histogram, frequency polygon cumulative frequency and normal distribution curve of hardness of PVC.

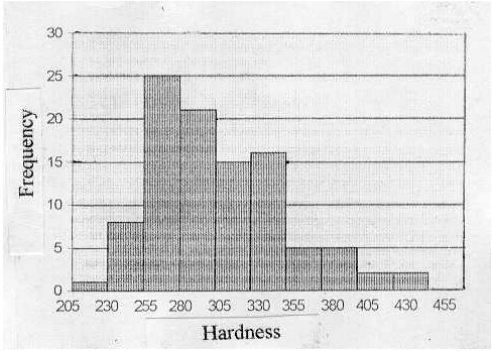

Fig. 9 Histogram of hardness values

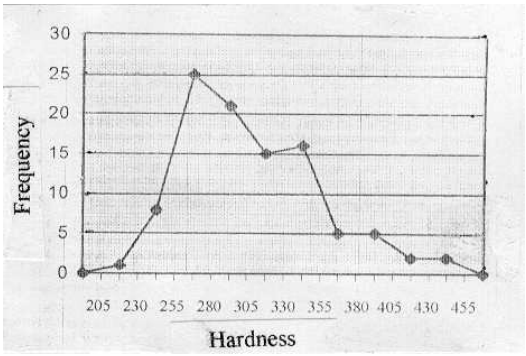

Fig. 10 Frequency Polygon of Hardness values

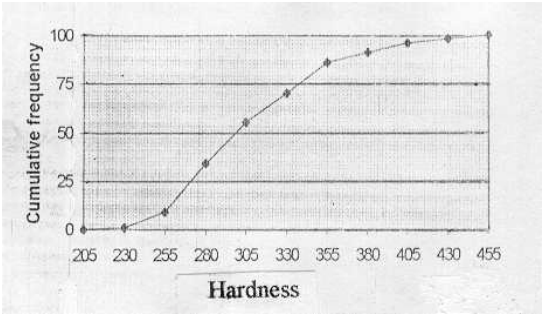

Fig. 11 Cumulative Frequency of Hardness values

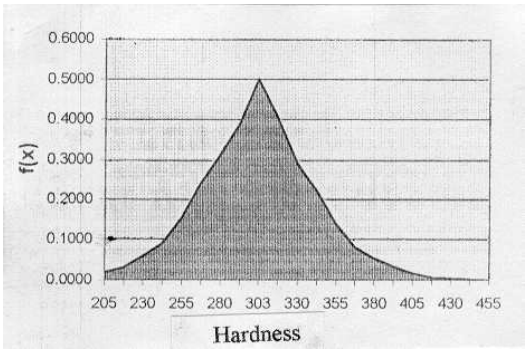

Fig. 12 Normal Distribution Curve of Hardness values

The mean and the standard deviation values of 100 samples are respectively 303.3 N/mm^2 and 47.42 N/mm^2. From the stress –strain diagram, the value of the modulus of elasticity is obtained. It is 3.85 GPa.

CONCLUSIONS

- The value of the tensile strength is within the standard range of the value for the PVC material.
- The value of the percentage of elongation is lower than the minimum value of the standard range of PVC material.
- The value of the modulus of elasticity is found to within the standard range of the value for PVC material.

REFERENCE

"Annual Book of ASTM Standard", Section 8, 1999