EXPERIMENTAL INVESTIGATION OF MATERIAL PROPERTIES OF EPOXY GRANITE

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Abstract—Precision of machining is influenced by stiffness, long term thermal stability, damping properties of structural material used for machine tool. The traditional structural material like cast iron exhibit low damping, long manufacturing lead time, high cost. Epoxy granite an alternative material which exhibit good material properties like high stiffness, damping and coefficient of thermal expansion.

Keywords: Damping, Epoxy granite, Modulus of elasticity, Strength

I. INTRODUCTION

The traditional structural materials used for machine tools such as cast iron produce positional errors occurs due to vibrations are transferred at high cutting speed .This is due to poor damping which affect the accuracy of the parts produced on it. This can be minimized by providing stiffer structures having thicker sections. Due to this the weight of structure increases which costs more. Also long manufacturing time, high material cost of traditional materials increase the cost of machine tool.

Hence an alternative material which provides high stiffness and damping is used for making machine tool structure. One of the alternative materials is epoxy granite which exhibit good material properties like high stiffness, damping and coefficient of thermal expansion. In this study, the material properties of epoxy granite such as compressive strength, flexural strength, modulus of elasticity, damping was investigated experimentally**.**

II. TEST SPECIMEN PREPARATION

The epoxy granite specimen was prepared with granite as filler which was crushed and sieved .The coarse aggregate size was 0.5-3 mm, 3-5 mm, 5-8 mm and fine aggregate size was lower than 0.5 mm. The epoxy resin used as matrix material was Araldite 103 and hardener was HY 951. The filler 90% by weight and epoxy resin 10% by weight including hardener was used for specimen preparation. The test specimen was cured for 24 hours at room temperature.

III. EXPERIMENTS

A. Compressive strength and Density

To find compressive strength and density of epoxy granite, ASTM C 39 standard was referred. The diameter and height of test specimen was 75 mm and 150 mm respectively. The compression test was conducted on universal testing machine of 600 kN capacity. The load was applied till failure continuously without shock at the rate of 1.25 kN/s to cause stress of 0.25 ± 0.05 MPa/s in the specimen.

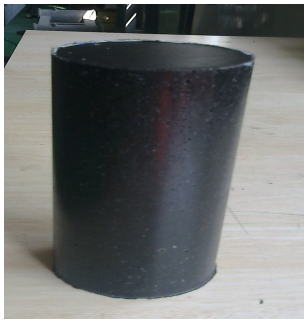

Fig. 1 Compression test specimen

Fig.2 Compression test Set-up

The maximum compressive load for each specimen was noted and divides it by the corresponding cross-sectional area to get compressive strength. Table I shows the values obtained for compressive strength.

Table I: Compression test result

Specimen No.	Maximum load (kN)	Compressive strength (MPa)
1	407	92.32
2	382	86.70
3	403	91.22
4	361	81.97

Density of epoxy granite is given by.

$$\rho = \frac{m}{v} \quad (1)$$

Where, 'm' is mass of specimen in Kilogram, 'v' is volume of specimen computed from the average diameter and average length in m^3.

$v = 6.63x\ 10^{-4}\ m^3$

$m = 1.580$ Kg

$\rho = 2383\ Kg/mm^3$

B. Flexural strength

To find flexural strength of epoxy granite ASTM C 580 standard was referred. For this test, specimen geometry was 50mm x 50mm x 300 mm. To achieve strain rate of 0.01± 0.001 per minute, cross head speed of 2.15 mm/Min was set on testing machine.

Fig. 3 Flexural test specimen

Fig. 4 Flexural test set-up

The flexural strength(S) at maximum load is calculated by,

$$S = \frac{3PL}{2bd^2} \quad (2)$$

Where, 'P' is maximum load, 'L' is span, 'b' and'd' are width and depth respectively. Table II shows the values of flexural strength obtained.

Table II: Flexural test result

Specimen No.	Maximum load (kN)	Flexural strength (MPa)
1	8	24.46
2	8.9	27.26
3	8.6	26.21
4	7	21.35

C. Damping

The test specimen was tested as per test set shown in fig. The cantilever beam was subjected to free undamped vibration, which damped in the course of time. Fig. 5 shows test set-up for damping test.

Fig. 5 Damping test set-up

The values of amplitude were recorded. Based on these values logarithmic decrement (δ) and critical damping (D) were calculated.

$$\delta = \left(\frac{X1}{X2}\right) \quad (3)$$

$$D = \left(\frac{\delta}{2\pi}\right) \quad (4)$$

Where, X_1 and X_2 are two successive amplitudes. Table III shows the logarithmic decrement and damping of cast iron and epoxy granite. Fig. 6 show displacement vs. time curve of cast iron and epoxy granite obtained during damping test.

Table III: Damping test result

Test No.	Cast iron		Epoxy granite	
	δ	D	δ	D
1	0.358	0.057	0.595	0.095
2	0.298	0.047	0.539	0.086
3	0.366	0.058	0.741	0.118

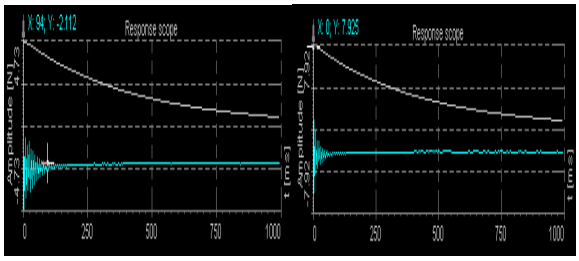

Fig.6 Displacement vs. time curve for a. Cast iron b. Epoxy granite

IV. RESULTS AND DISCUSSION

I. Compressive strength

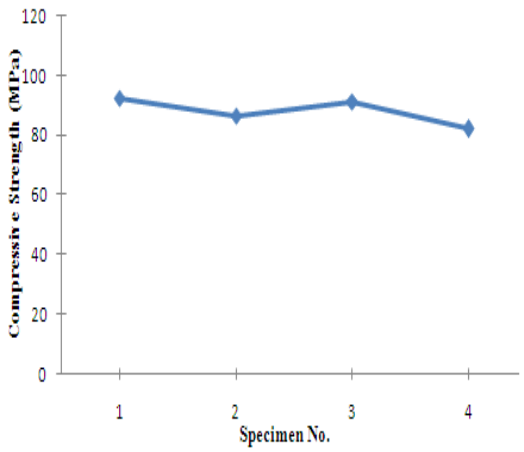

Fig. 7 Variation in compressive strength

Fig.7 shows the variation in the compressive strength of epoxy granite. The observed values of compressive strength were 82 to 92 MPa.

II. Flexural strength

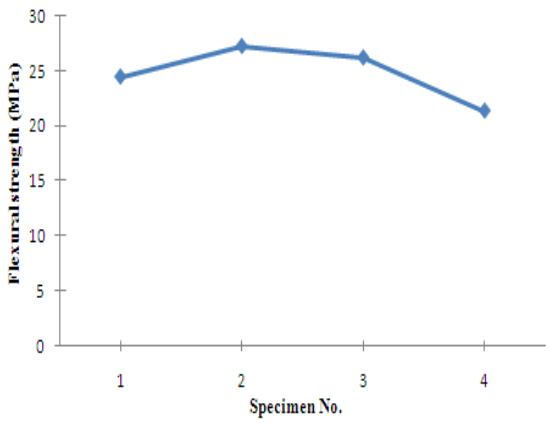

Fig. 8 Variation in flexural strength

Fig.7 shows the variation in the flexural strength of epoxy granite. The observed values of flexural strength were 21 to 27 MPa.

III. Damping

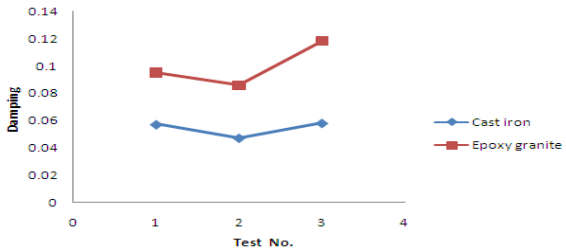

Fig. 9 Variation in damping

Fig. 9 shows the variation in damping obtained in cast iron and epoxy granite. The value of average damping for cast iron is 0.054 whereas 0.1 for epoxy granite. The average damping of epoxy granite is approximately two times greater than that of cast iron.

CONCLUSION

Density of epoxy granite is approximately three times lower than cast iron. At this lower density it dampens the vibration at faster rate as compared to cast iron. Also the manufacturing lead time is less. Hence it provides an alternative to traditional materials for machine tool manufacturer.

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